Subliminal Priming and Mood: A Preliminary Study

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ABSTRACT

The topic of subliminal perception (perception without awareness) is investigated in this thesis. A technique of masking by visual noise was developed for use with an *IBM*-type microcomputer and *VGA* screen. This technique was used to investigate whether subliminal mood priming influences subjects' resolution of lexical ambiguity in a homophone task designed by Halberstadt *et al.* (1995). Limited evidence was found for mood-congruent priming, but only for negative emotional priming, and with the most strongly negative items. Some non-specific effects were also found to be associated with negative mood priming. The mood-priming effect was correlated with the negative emotional ratings of these items obtained from a separate group of subjects. In a Follow-up study, a self-report mood scale was used to assess subjects' reaction to both negative and positive subliminal stimuli. A pattern of trends was found which suggested that subjects experienced a paradoxical improvement in mood after exposure to the negative stimulus. No changes were observed in the group exposed to the positive stimuli. A theoretical explanation was entertained which suggested that subjects adaptively attributed their change in affective arousal in terms of experimental demands. of A number of relationships to recent research were suggested by these experiments, in particular the finding of a preattentive bias for negative information in subjects with anxiety and non-clinical depression by Bradley *et al.*, (1994, 1995) and Mogg *et al.*, (1993). It is suggested that measures of physiological and cortical arousal should receive attention in future research in order to clarify the response to subliminal stimulation in terms of affective arousal.

DECLARATION

The study described in this thesis was conducted in the Department of Psychology, University of Natal, Pietermaritzburg, under the supervision of Professor Lance Lachenicht. It represents original work by the author, and has not been submitted in any form for any degree or diploma to any university. Where use has been made of the work of others, it is duly acknowledged in the text.

PREFACE

The research for this thesis began when I read an article by Patton (1992) on a Subliminal Psychodynamic Activation (SPA) investigation of the theory that binge eating episodes may be triggered, in those sufferering from bulimia, by an unconscious fear of abandonment. In the article, Patton described a fascinating experiment in which an analogue eating-disordered sample was induced to eat more crackers in an experimental task, after subliminal exposure to an abandonment threat phrase. Patton's article introduced me to the huge body of research on SPA, and led me to ask the question, along with many other researchers, 'Is this a genuine phenomenon, and if so, how does it work?'

I started my investigation with little knowledge about subliminal stimulation, and with a odd-looking device from the department workshop which was thought to be a tachistoscope, but did not seem able to do any of the things that the sophisticated (and expensive) devices described in the literature could. I did not know at the time whether a personal computer, and *VGA* screen had ever been used for subliminal stimulation, and set out to see if this was feasible. I must give credit to Professor Lachenicht at this point, since he was adamant that it should be possible to achieve subliminal exposure levels with the *VGA* screen.

This research project began therefore, with the development of a method of subliminal stimulation, virtually from scratch. It has been a process of exploration for me, both with regard to the method and theories of subliminal perception, and this will probably be evident to the reader. The use of various methods and statistical techniques has necessarily been tentative exploratory, and in the process, many different hypotheses and explanations have been entertained. Entering this area of research from a position of ignorance, as I have done, has also given me the luxury of being uninvested in any particular theoretical position, but has left me with the need for a coherent framework within which to view my results. I have to concede, that much of the theorising done in this thesis has been *post hoc* in nature. A fairly consistent pattern of statistical and theoretical findings has emerged from the research however, and gives me the hope that this research will provide a basis on which more specific research questions and hypotheses may be posed.

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Professor Lance Lachenicht, for supervising this work, referring me to valuable sources of information and for the loan of various resources. I would like to thank Professor Lachenicht for his availability, the time he spent assisting me, and his invaluable expertise.

My whole family (Valerie and John Dold, Kate and Robin Gunter, Beverley and James Horsley) has always been enormously supportive and I would like to express my gratitude to them all. My mother, Mrs Valerie Dold has been very generous with financial assistance, and deserves special thanks.

Marina Bang, and Barbara Florence assisted me greatly by proof-reading the text. I would like to thank them both for their assistance in this regard. In general, I would also like to thank all my friends for their support during the writing of this thesis.

I would especially like to thank the second year psychology class of 1996 for participating in the various experiments. Their enthusiastic participation made the work enjoyable for me.

The honours students who participated in various parts of the research, and all those who were willing to be subjects in the early part of my research.

I would also like to thank all the staff of the Psychology Department who filled in and distributed questionnaires, and in many ways made both direct and indirect contributions to my research.

We learn by taking chances. Every modern learning theorist expects learning to be by trial with some errors. This is as true for science as for the individual.

(John, W. Tukey, 1969)

Seriousness is stupidity sent to college.

(P. J. O'Rourke, 1992).

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NOTE: The raw data from the experiments is available to the interested reader, and was not included because of its extent.

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1. INTRODUCTION

1.1 GENERAL

This thesis seeks to investigate the area, often referred to as 'subliminal perception', specifically with regard to the question of how words presented below the threshold of perception may affect mood and cognition. This subject has been the subject of controversy for some time, and a range of effects have been claimed. It seems that there is some agreement in the literature, especially in the last decade, that subliminal perception, or 'perception without awareness' is a genuine phenomenon, and worthy of serious research.

This thesis describes the literature on subliminal perception, and attempts to integrate the findings of various research paradigms (psychoanalytically vs. non-psychoanalytically orientated research). A major contention of this author, is that while these paradigms stem from different theoretical orientations, and frame their experimental findings in seemingly incommensurable ways, some integration is possible at a basic level of description. In the Survey of Literature, these paradigms are compared, and critiqued.

Some time needed to be spent examining the evidence for subliminal perception, and establishing the conclusions which have been reached by experimenters in recent years. A discussion of perception without awareness needs to address the question of consciousness, and the difference between conscious and unconscious processes. The discussion has mainly revolved around empirical research, and the operational definitions of conscious vs. unconscious processes.

The basic question explored in this thesis concerns subliminal priming and mood. The experiments were designed to answer the question of whether subliminally presented phrases (negative or positively valenced) can affect the manner in which subjects access the various meanings of ambiguous words. A secondary question, arising from this one, concerns subjects' experience of subliminal stimulation. Follow-up research asks the question, 'Does any measurable change in mood occur when subjects are presented subliminally with different mood suggestions.

I would like to point out that the entire thesis is, in effect, an exploratory study of subliminal priming and mood. Historically, the most usual way of presenting stimuli below the perceptual threshold was by means of a tachistoscope. This is an expensive instrument however, and none was available for this research. Because of the ease with which a microcomputer may be programmed, it seemed that this was probably a better alternative in many ways. However, little information was available on the use of the microcomputer and *VGA* screen with subliminal stimulation, and so far as I was aware at the time, a technique had to be pioneered. Everything that was done for this thesis has an exploratory flavour to it, since this area was quite new to me.

The various *Pascal* computer programs used for the experiments, and for scoring and analyzing the data are given in the Appendices.

The stages of experimentation are as follows:

1. A method of visual masking was developed to run on an *IBM*-type 80486 computer whereby visual stimuli could be presented below the perceptual threshold. The development of this procedure is described in the chapter entitled *Pilot Study* (Chapter 3).
2. The *Main Study* (Chapter 4) describes the use of the masking technique with various mood-type phrases ('sad' and 'happy') where the research question concerned the resolution of lexical ambiguity by emotional state (based on the research of Halberstadt *et al.* 1995). The experiment was run with a sample of 108 subjects with computers linked to a file server, and the question was posed, 'Can subliminally presented mood stimuli affect subjects' spelling of ambiguous words (homophones)?
3. With some encouragement from the Main Study that the technique worked, the *Follow-up Study* (Chapter 5) was designed to answer the question 'Do subjects experience a change in mood after subliminal stimulation, which could be reflected in their responses to a self-report mood scale?'

Because of the complexity of the effect associated with priming, extensive data analysis was done. The analysis was thought to be justified, since little was known about subliminal mood priming, and the experiment was deliberately exploratory in nature. Justification for this approach to statistical analysis is found in the method termed *Exploratory Data Analysis*

(EDA) and attributed to John Tukey. This is set out and discussed briefly in Chapter 6.

I would like to apologise in advance for the complexity of the analysis presented in Chapter 4. In order to 'unlock' the secrets contained in the data, an intensive item analysis was necessary. This appeared to thrown some light on the effects obtained, and attributed to the subliminal priming. In order to study the data, several statistical models were used:

1. A principle components analysis was done to summarise the determinants of variance.
2. An factorial analysis of variance model was used to test for group differences.
3. A non-parametric Chi-square analysis of the items was done to assess the effects of the independent variable *subliminal condition* on subjects' responses to the homophone task.

An independent rating of the homophones was done, and an interesting set of correlations was observed which suggests that items were sensitive to negative, but not positive priming.

1.2 ETHICAL CONSIDERATIONS

It seems necessary at this point to discuss the ethical considerations of exposing subjects subliminally to aversive stimuli. Lasser (1977) raised a concern in a letter addressed to Silverman, that his experiments were unethical for the reason that they were designed to 'stir up unconscious conflict, and thus increase psychopathology...' Lasser pointed out that even though the negative effects were transient, the mere fact that pathology-enhancing experiments were conducted was difficult to justify ethically.

Silverman's reply sets out 4 considerations:

1) In his experiments, informed consent was regularly obtained.
2) Intensification of pathology by means of Subliminal Psychodynamic Activation (SPA) is 'with rare exceptions' slight, and fleeting (see Section 2.5 for a definition). Moreover, pathology-intensifying stimuli are used in one session only, as opposed to pathology-reducing stimuli given for therapeutic purposes, which are given repeatedly.
3) Extensive debriefings were given to participants after the experiment and in particular, care was taken to reveal the content of the stimuli. Silverman remarks that in their experience, this 'lessens the possibility of any lingering negative effects' (in Lasser, 1977, p. 578).
4) In the rare instances where negative effects arose from the experimental manipulation, clinical interviews were conducted, and further action was taken.

The subjects who participated in the Main Study, admittedly, were naive to the nature of the study, and were not informed until after the experiment. However, the aversive subliminal stimulus phrase was mild ('Sad and grey'), and on the basis of the literature consulted, it did not seem likely that any negative effects would be experienced. A relaxation exercise was built into the procedure in order to counter experimentally induced anxiety that may have occurred. In the Follow-up Study however, where a more noxious phrase was used, informed consent was obtained verbally from all subjects when they were invited to participate. All subjects were informed that the experiment would involve subliminal exposures of a similar nature to those used in the Main Study.

The claim by Silverman, that intensification of pathology by means of subliminal stimulation is slight appears to be consistent with the literature consulted in the review of SPA literature in that effect sizes are generally small (see Weinberger & Hardaway, 1990). On the basis of this, it was felt that the risk of complications arising from this research was slight.

Particular care was taken to debrief the subjects in the Follow-up study, and to make an assessment of their post-test mental status, based on both a subjective assessment and examination of the subjects' post-test mood scores. If subjects expressed any concerns, more time was spent debriefing, and discussing their response. All subjects were invited to contact the experimenter if any ill effects had occurred, or if they experienced anything (such as dreams or feelings) which they thought were unusual and might be related to the experiment. Each subject was later sent written feedback on her participation in the experiment. This was done because of the nature of the psychometric tests, and for ethical reasons. Since the General Health Questionnaire is an instrument designed to screen for psychopathology, and the Profile Of Mood States is a potential indicator of disturbance, the experimenter felt obliged to reflect the results of this test to the subjects in an appropriate manner if there was any cause for concern. Instead of singling out subjects whose results seemed problematic, I decided to incorporate a brief performance report with a letter of thanks to each subject, highlighting if necessary, any concerns and inviting the subjects to contact the experimenter if she needed assistance or had queries arising from the experiment. In general, the mood of participants was either unchanged, or improved (according to scores on the POMS) after the subliminal intervention, so it does not generally seem likely that any significant distress resulted.

Fourthly, no instances of complications were reported by any of the participants. Since the hypotheses explained to the subjects as part of the debriefing procedure were not supported, and others were formulated, the subjects were all sent copies of a letter asking if they would like to be informed about the results of the research, and inviting them to participate in further research, should this occur. Subjects were also invited to contact the researcher if they had any queries related to the research. Although 10 of the subjects replied, none had queries related to the research.

On the basis of these considerations, it is claimed that the research conducted did not cause the participants any significant degree of distress, and that it was done in an ethical manner.

1.3 CONVENTIONS

In this thesis, words such as *condition*, *sad, happy, neutral, sad/neutral happy/neutral,* are italicised because they are used as variable names, and refer to actual independent of dependent variables used in the analysis. Quotes are used with words such as ‘sad’ and ‘happy’ or ‘neutral’ when they refer to words characterised as such, although this characterisation is not absolutely self-evident.

2. REVIEW OF LITERATURE

2.1 INTRODUCTION

Subliminal stimulation is a large, fascinating, and extremely controversial subject which touches on many different areas of research. For this reason, a number of theoretically distinct fields are referred to in this review of literature. In each field, there exists a substantial body of literature which spans many years of research. In the area of visual masking, I have drawn heavily from the work of Breitmeyer (1984). Breitmeyer's book usefully summarises the vast and complex literature on visual masking. Another book found to be useful was that of Dixon (1981) which provides a helpful summary of the earlier literature on subliminal stimulation. These works have proved to be valuable entry points into the more recent literature of what could be referred to generically, as subliminal research.

This review aims to give the reader a general overview of the subliminal research, and to highlight conclusions which may be drawn from it. In selecting literature, I have tried to focus on the most central and important findings. Because the topic of subliminal stimulation is an extremely controversial one, it seemed necessary to spend some time establishing the empirical basis from which research into *perception without awareness* has come to be regarded as a worthwhile area of inquiry. The content and extent of the survey was somewhat constrained by the availability of journals, and the literature presented here is only a sample of the published research. This literature is highly detailed and complex and the single greatest challenge for this author has been to interpret and synthesize this fascinating but conflicted body of research.

In this chapter, two research paradigms, or traditions are discussed and compared (Subliminal Psychodynamic Activation vs. non-psychoanalytically orientated research), and a suggestion is made that while these research paradigms stem from vastly different theoretical orientations, they need not be regarded as incommensurable. In reviewing evidence for subliminal effects, various findings will be presented and discussed. The conclusion is reached in this chapter that a substantial amount of research clearly establishes the existence of perception and cognition without awareness. This conclusion is based on evidence from both research paradigms alluded to, and while significant common ground exists between them, some gaps in the psychoanalytically orientated research exist and need to be addressed by means of more discrete and narrowly defined research.

2.2 THEORY AND DEVELOPMENT OF MASKING PROCEDURES

In this section, a brief introduction is given to the theory of visual masking, and it is suggested that this technique offers a way in which conscious and unconscious processes may be explored. The focus of the discussion is the disruptive effect of masking on visual perception. Visual masking refers to the technique used to modify perception of visual targets by preceding or following the target with a flash of light, or the exposure of a pattern in the target area. The technique has been extensively used to research processes and stages of visual perception, and it is often used as a method of stimulus degradation to prevent **conscious** perception, registration and identification of stimuli. Masking by light and masking by pattern (also referred to as masking by visual noise) are two types of masking commonly used.

In early research, visual masking was used to investigate the effects of sudden changes of visual sensitivity in terms of light and dark adaptation, but later researchers focussed on temporal aspects of the perception and processing of visual stimuli. In the first type of research mentioned, it was found that as masking flash intensity increases, overall visual sensitivity decreases. Conversely, as masking flash intensity increases, visual sensitivity thresholds increase. By using a masking flash, registration of a prior stimulus may be affected for up to 100 ms. In other words, any stimulus displayed for up to 100 ms before the masking flash may be affected by it in terms of a reduced sensitivity. The brighter the masking flash, the less sensitive subjects were to preceding stimuli. It is not clear if this effect is due to changes in the sensitivity of the photoreceptors alone, or if there are accompanying neural adaptations. In research carried out by Boynton and Kandel (1957, cited by Breitmeyer, 1984, p. 39-42) there appears to be evidence for both. These authors showed separate effects of photochemical depletion in the photoreceptors, and reduced sensitivity in neural systems as a function of light adaptation.

According to Breitmeyer, Exner (1868, in Breitmeyer, 1984) was the pioneer of the method of backward masking by light, and this method has been employed extensively in subsequent research. The backward masking by light technique consists of presenting a stimulus flash (target) followed at some measured time interval, by another non-stimulus (mask) flash.

Breitmeyer summarises the general findings of subsequent research as follows:
(1) 'the more intense the after-coming mask flash, the less the visibility of the prior target...'
(2) 'the greater the temporal interval between prior target and succeeding mask, the weaker the masking magnitude' (p. 17).

A theoretical explanation offered for the masking by light effect is the sensory persistence hypothesis (Eriksen, 1966, cited by Breitmeyer, 1984, p. 17). In this view, the target stimulus persists in the visual system as a decaying visual after-image and the mask that follows, causes interference by combining, or becoming integrated with it. Thus, the decaying after-image from the target merges with the subsequent blank, and usually brighter, masking field and becomes indistinguishable from it. Marcel (1983) asserts that energy masking does not operate merely at a physiological level, such as that where changes in photoreceptors occur, but also at a psychological level. This is supported by Boynton and Kandel's research (1957, *op cit.*) where separate neural and photochemical changes were observed.

Backward masking by visual noise is similar to the masking by light technique except that a mask consisting of random characters or markings is used instead of the bright masking field. Masking by light is sometimes thought of as a type of energy masking which may be explained by the sensory persistence hypothesis. Turvey (1973, in Marcel, 1983) suggests that masking by light operates at a more peripheral stage of perception. Marcel (1983) qualifies this by speculating that with masking by light, the contour information of the stimulus is degraded before it can be graphically analysed. This is consistent with the sensory persistence hypothesis, that the target stimulus merges with the mask. It is suggested that visual noise masking, on the other hand, affects a later, or more central stage of visual processing.

The sensory gating hypothesis described by Mayzner, Tresselt and Helfer (1967, in Kahneman, 1968) is somewhat different to the sensory persistence explanation. According to these authors, the effects of discrete stimuli are particularly susceptible to interference by subsequent and temporally close stimuli (within approximately 100 ms). They suggest that visual input is slightly delayed at a 'gate' prior to entry into awareness, and is particularly vulnerable to interference at this point of entry. Conscious recognition of the target stimulus is disrupted by the temporally close mask stimulus at the point of the sensory gate, and the target stimulus is thereby prevented from entering awareness.

The first hypothesis (sensory persistence) emphasises the **merging** of the temporally close mask flash with the stimulus, and thereby implies that features, or contours of the stimulus are degraded by the mask flash. This would preclude any further pattern recognition, and the implication is that degradation occurs at a more peripheral level. The second hypothesis (sensory gating) stresses the disruptive effect of the mask on conscious recognition of visual data. It is thought to be a more central method of masking since the contours of the stimulus are not degraded by the mask. The notion of a 'gate' may be a helpful way of expressing the slight delay between preconscious and conscious processing of stimuli. Perhaps conscious recognition of stimuli is determined by means of various templates (corresponding with perceptual defences - see Dixon and Henly, 1991 for a discussion of differential stimulus thresholds), in which case the notion of a 'gate' would be appropriate.

Both hypotheses agree that there is a delay between registration of a visual stimulus and awareness. The first suggests that the mask merges with the stimulus, and the second suggests that the mask interrupts, or prevents further processing of the stimulus. It may be that these theories explain the two different types of masking: the first explains the masking by light effect, while the second explains the masking by visual noise effect.

Masking effects are of central importance to the present thesis because they have implications for the process of visual perception - namely those of (1) registration of a stimulus and (2) recognition, or what may be termed 'cognitive categorisation' (Breitmeyer, 1984 p. 24). Breitmeyer concludes that while the exact process of visual processing which masking disrupts is not clear from the research, it may be thought of in approximate terms as intervening between registration and recognition of the stimulus. The processes of registration and recognition may be conceptualised respectively as *perception* ('entry of the visual impression into consciousness') and *apperception* ('the entry of the conscious impression into the focal point of awareness') (Wundt, in Breitmeyer 1984, p. 24). Using Wundt's terminology, visual masking could then be considered as intervening between processes of perception and apperception. The more precise notion of *iconic* memory is suggested by Neisser (1967, in Breitmeyer, 1984) as a stage of registration at which a 'literal' representation of the stimulus occurs, although it has not been further processed or categorised (Breitmeyer, 1984, p. 24).

Making a clear distinction between registration of a stimulus, and the entry of this data into 'the focal point of awareness', Breitmeyer implies that processing beyond the stage of iconic representation is effortful. That is, the transfer of information from the stage of iconic registration to that of cognitive representation requires conscious effort. Visual masking thus prevents the transfer of stimulus data from a 'precategorical, literal visual representation or icon of the stimulus' to a higher level of 'cognitive categorical representation' because it causes a diversion of attention (*ibid.*). Marcel (1983) suggests that this interpretation of masking is widely accepted, and ascribes it to Sperling (1967) and Turvey (1973) (both in Marcel, 1983).

Proponents of this interpretation suggest therefore, that visual masking disrupts the availability of raw representation of visual input (iconic memory), without which it cannot be processed to achieve semantic or phonological encoding. This means that the masking by light effect is not merely due to changes in sensitivity of the photoreceptors and visual neurons, but concerns a disruption of the process by which raw data is further encoded. It also suggests that visual information stored briefly in sensory registers is unavailable to consciousness if it cannot be transferred to the processing stage described as that of *apperception* or conscious cognitive categorisation. In remarking on the subjective effects of visual masking, Breitmeyer cites an interesting observation made by Cattell (1885):

> In making these experiments I notice that the impressions [of briefly exposed letters, words or sentences] crowd simultaneously into my consciousness, but beyond a certain number, leave traces too faint for me to grasp. Though unable to give the impression, I can often tell, if asked, whether a certain one was present or not. This is especially marked in the case of long sentences; I often have a curious feeling of having known the sentence and having forgotten it. The traces of impressions beyond the limits of consciousness seem very similar to those left by my dreams (cited by Breitmeyer, 1984, p. 24).

Cattell gives an interesting account of his own familiarity with targets which could not be recalled, but that could later be recognised. This remark is an interesting antecedent to the research into perception without awareness which will be discussed later in this chapter. On the basis of Cattell's account and subsequent research, one may readily speculate that memory traces of visual stimuli persist in some form, even if partially unavailable to consciousness.

Theories of visual masking are diverse, but have in common the idea that 'the visual response to a brief stimulus lasts much longer than did the stimulus that caused it; consequently the response to two successive stimuli may overlap in time' (Kahneman, 1967, p. 419). The technique offers, potentially, a way of interfering with the process of perception by interrupting the normal signal processing path so that masked stimuli may be registered in the visual cortex, but not enter consciousness. Dixon (1981) refers, for example, to 'preconscious processing' as the facility in which perceptual information is processed before its entry into awareness'.

2.3 THEORETICAL ASPECTS OF THE TERM 'UNCONSCIOUS'

A logical starting point in a review of literature on unconscious perception would be a discussion of what is termed 'the unconscious'. Discussion of this issue however, leads into the midst of a thorny debate. At the theoretical level, it is difficult to define the nature of consciousness, quite apart from making viable distinctions between what is conscious and unconscious. At the empirical level, it is certainly difficult to operationalise such a concept in a valid, or at least defensible manner.

Definitions of the 'unconscious' tend to be circular, and one faces the considerable difficulty in the first place, of establishing the nature of consciousness. This leads into the fundamental philosophical problem of mind which needs to be acknowledged, but which cannot be explored in a work of this length. The Cartesian intuition of an ontological difference between mind and brain is certainly currently regarded as passé, yet interestingly, is still treated as an important reference point - even if it has become an *Aunt Sally.* Identity theories of mind appear to be current, and without professing any commitments to them, or espousing philosophically strong views regarding ontology, this author has found them to be a useful focus for the problem of mind[1].

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[1] In particular, Strawson (1959) suggests a useful synthesis in his book *Individuals: An Essay in Descriptive Metaphysics.*

The American Heritage Dictionary of the English Language (1992) defines the word 'unconscious' in its adjective form in 4 ways:

1. Lacking awareness and the capacity for sensory perception; not conscious.
2. Temporarily lacking consciousness.
3. Occurring in the absence of conscious awareness or thought: unconscious resentment; unconscious fears.
4. Without conscious control; involuntary or unintended: an unconscious mannerism.

In its noun form, the word is taken to signify:

> The division of the mind in psychoanalytic theory containing elements of psychic makeup, such as memories or repressed desires, that are not subject to conscious perception or control but that often affect conscious thoughts and behaviour.

It is interesting to see the distinction made in a generalist publication of this kind, between informal and formal notions of unconscious processes. Informal (adjectival) descriptives of unconscious processes appear, amongst other things, to refer to events which occur in the absence of conscious awareness, thought or control, and they are referred to here as informal because they are not associated with a specific theoretical superstructure. The more formal (noun) description of the unconscious is often associated with a more systematic theory of mind, namely psychoanalysis.

The non-psychoanalytic notion of 'unconscious' phenomena appears to be less specific, and does not entail psychoanalytic constructs. Use of the term 'unconscious' often seems to be avoided by these theorists because of its association with psychoanalysis. Instead of employing the term 'unconscious' for example, Bradley *et al.* (1994) use the notion of 'implicit memory' to refer to biases in 'early' attentional and perceptual processes. The word 'early' here refers to a stage of information processing in terms of its order of occurrence. Clearly though, the term 'unconscious' may be used to refer to processes and entities apart from the theory-specific constructs of psychoanalysis.

The psychoanalytic paradigm[2] is explicitly linked to 'Subliminal Psychodynamic Activation' (SPA) research - an approach pioneered by L. H. Silverman in 1964 (according to Schulman, 1990) who published the bulk of his experimental findings from 1974 to1985. In this approach, subliminal stimulation is understood to bypass 'certain ego defences that require conscious awareness of stimulus content in order to be effective' (Bornstein, 1992, p. 70). It may be said that proponents of this position are indebted to psychoanalysis for their understanding of psychic structure, the nature of the unconscious and explanations of experimental findings.

Non-psychoanalytic conceptions of unconscious psychological processes are largely independent of traditional psychodynamic constructs, and an impressive body of research data has been created over the years. Kihlstrom *et al.* (1992) claim that 'After 100 years of neglect, suspicion, and frustration, unconscious processes have now taken a firm hold on the collective mind of psychologists' (p. 788). These authors suggest that the study of so-called 'subliminal perception' is no longer seen as entailing a commitment to psychoanalysis. Authors who are more antagonistic to psychoanalysis imply that by the same token, investigation of unconscious processes has gained a degree of scientific credibility.

There is a large and self-critical body of recent research in this area which has surfaced independently of psychoanalysis. Reading in this area heightens awareness of the inherent difficulties of research, and Erdelyi (1992) captures this sense by his injunction that the unconscious should be 'reclaimed gingerly'. The reason for the apparently renewed interest, and the emerging consensus that unconscious processes can be the subject of serious scientific study, appears to be partly due to the influence of cognitive neuropsychologists and various other branches of experimental and social psychology. Kihlstrom *et al.* refer to research into the 'Non-Freudian Unconscious' as a species of scientific psychology, by implication, unlike that of Freud. According to these writers,

> ...the psychological unconscious documented by latter-day scientific psychology is quite different from what Sigmund Freud and his psychoanalytic colleagues

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[2] The term 'paradigm' is not used here in its strictest Khunian sense which refers to scientific models which include '...law, theory, application, and instrumentation...' (Kuhn, 1970) from which emerge coherent traditions of scientific practice, but rather in the more casual sense of a distinctive theoretical and practical *modus operandi.*

> had in mind... Their unconscious was hot and wet; it seethed with lust and anger; it was hallucinatory, primitive and irrational. The unconscious of contemporary psychology is kinder and gentler than that, and more reality bound and rational... (p. 788).

While the 'scientific' basis for contemporary research into unconscious processes may be queried, much of it shows evidence of careful efforts by researchers to find links with other established fields of research. An interesting area in which unconscious phenomena are mentioned is that of neuropsychology where the 'blindsight' syndrome[3] (Weiskrantz, 1977, cited in Dixon, 1981) has been investigated. Findings in this area seem, in particular, to have alerted researchers to brain processes which appear to be mediated without representation in consciousness. Researchers in different fields such as cognitive psychology (eg. Greenwald *et al.*, 1995), advertising (eg. Kelly and Kessler, 1978 in Theus, 1994) and neuropsychology (eg. Làdavas *et al.*, 1993) have investigated specific aspects of unconscious processing using subliminal methods of stimulation.

2.4 SUBLIMINAL PERCEPTION

The term 'subliminal' is made up from the prefix *sub*, and the Latin term *lìmen,* meaning threshold, and refers in its psychological sense, to stimuli which are below the threshold of conscious perception. These stimuli, according to *The American Heritage Dictionary of the English Language* (1992), are 'Inadequate to produce conscious awareness but able to evoke a response'. In the public mind, subliminal phenomena are commonly associated with propaganda, advertising, and 'self-help' tapes. Attitudes do not seem to vary much, and subliminal stimulation is often regarded as sinister (subliminal propaganda), as a rather magical but coercive advertising technique, or as a type of self-help method (eg. giving up smoking, boosting confidence etc.). Some applications of subliminal stimulation will be briefly mentioned in this chapter.

Advertising research into effects of subliminal messaging on choice behaviours generally shows inconclusive or negative results (Theus, 1994), and certainly does not suggest that the technique can be applied indiscriminately with any degree of success. Although the author of

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[3] In this condition, patients with damage to the striate cortex of the occipital lobes are able to make discriminative responses to stimuli that they cannot report having seen.

the apparently original experiment (Vicary, cited by Theus, 1994) in which the phrases 'Eat Popcorn' and 'Drink Coca Cola' were presented tachistoscopically at 0.5 ms to an audience in a movie theatre, claimed increases in sales of these items, these findings have certainly not been replicated with any degree of reliability. With regard to advertising, Theus asserts that visually presented stimuli have a higher chance of being cognitively processed than do auditory stimuli. Theus concludes that stimuli relating to relevant need states are most likely to produce related behavioural changes. The psychological characteristics of the audience are plausibly an important factor, and effects depend therefore on susceptibility to psychodynamically relevant subliminal themes.

The research consulted on subliminal messaging in 'self-help' type audio tapes suggests that the claimed effect is either non-existent, or due to placebo (Mitchell, 1995; Pratkanis *et al.* 1994; Merikle and Skanes, 1992; Greenwald *et al.*, 1991; Russell *et al.*, 1991). Claims that backward messaging in music affects behaviour are apparently also not well-founded according to Vokey and Read, (1985). These authors conclude that 'the apparent presence of backward messages in popular music is more a function of active construction on the part of the perceiver than of the existence of the messages themselves'.

In reviewing evidence for the use of subliminal techniques as propaganda tools, Bornstein (1989) concluded that the research suggests that 'exposure to simple drive or affect-related subliminal stimuli can produce ecologically significant, temporally stable changes in attitudes and behaviour, and therefore may have potential for use as propaganda tools'. This conclusion agrees with that of Theus since both stipulate that messages need to be relevant to need or drive states in the target audience.

The three areas mentioned thus far with regard to subliminal perception, illustrate the variety of ways in which it has been applied or researched. It is not surprising, given the number of spurious claims about the efficacy of the method, that research in this area tends to be regarded with scepticism. A sceptical attitude about subliminal effects is certainly justified, and should in fact be cultivated. An appropriate response would therefore be to view any methodology critically, and to employ appropriate controls in experimental design.

2.5 SUBLIMINAL PERCEPTION: RESEARCH PARADIGMS

The expression 'perception without awareness' is a way many authors refer to 'subliminal perception' without invoking the connotations of the latter phrase. Some authors find it useful to characterise such phenomena in this way since this phrase carries fewer assumptions, and is more precise. In this thesis, no particular theoretical framework is implied by the use of the term 'subliminal perception', and these terms are used interchangeably unless otherwise stated.

Attention was drawn earlier, to the uses of the word 'unconscious', and it was pointed out that a distinction can often be drawn between schools of thought on the two ways in which the word is used. The noun reference to 'the unconscious' was seen as referring to a specific theoretical position, namely psychoanalysis. The word is also used more informally and atheoretically to refer to specific processes which occur without conscious awareness. This is a term used to refer to a greater diversity of empirical phenomena.

Two different traditions have emerged from research into the unconscious. The first of these has strong links to psychoanalysis, and is partly a reaction to criticism that psychoanalysis lacks a basis of empirical support for its assertions (Shulman, 1990). The rivalry between psychoanalysis and other schools of thought can hardly be overstated. For example, Eysenck's suspicion of psychoanalysts' reliance on clinical data led him to remark that 'We can no more test Freudian hypotheses on the couch, than we can adjudicate between the rival hypotheses of Newton and Einstein by going to sleep under an apple tree' (Eysenck, 1963, in Shulman, 1990).

Subliminal perception was seen by psychoanalytically inclined researchers as a tool by which the unconscious could be investigated, and this issued in the Subliminal Psychodynamic Activation (SPA) research paradigm. SPA seeks to investigate specific psychodynamic formulations and propositions experimentally.

Other approaches to investigating the unconscious are also based on experimental methodology, and whilst they do not collectively constitute a distinctive approach, they use traditional experimental methods, and tend to be associated with a wide range of more empirically based theories.

The term 'paradigm' which is used to characterise these research traditions, is used in its more casual philosophical sense for convenience sake because it is has some currency in terms of this meaning. It would certainly be inaccurate to characterise these two orientations as being separate paradigms in the stronger Kuhnian sense however, and this brings to light a tension in the literature. There appears to be little in the way of discussion which synthesises the findings of the two research paradigms referred to here. It is important to make this point since the strict use of the term implies that research data generated in different paradigms cannot be compared. This is because of the assumed dependency of the data on the method of observation used, and the incommensurability of the associated theoretical constructs. Kuhn made this point with an illustration of the separate accounts of a helium atom that a physicist and a chemist would give. For the chemist, 'the atom of helium was a molecule because it behaved like one with respect to the kinetic theory of gases'. For the physicist on the other hand, 'the helium atom was not a molecule because it displayed no molecular spectrum'. Kuhn's understanding of this theoretical difficulty is that while both scientists were talking about the same entity, they were 'each viewing it through their own research training and practice' (Kuhn, 1970, p. 50-51). Now in practice, one gains the impression that data generated within the two research paradigms are viewed and treated as incommensurable because of the way that the data is perceived to be dependent on (or even *determined* by) a theoretical superstructure. There is apparently little communication across this theoretical divide, and researchers in one tradition tend either to ignore, or to be unaware of the findings emerging from the other.

The idea that these research orientations are incommensurable may be rejected on the basis, suggested by Popper, that science is distinguished from non-science by the notion of potential falsifiability[4]. This provides a basis for agreement on findings, provided that hypotheses are narrow and separated from generalisations suggested by high-level ideological or quasi-scientific dogmas. Provided that hypotheses are specific and potentially falsifiable, they do not need to be seen as inextricably linked to a particular (perhaps highly disputed) theoretical

[4] An elegant exposition of this position is given by Popper in his book Quantum Theory and the Schism in Physics (1982) in which he argues for a *realistic* or non-idealistic interpretation of quantum theory. He argues that science may progress on the basis of rational argument, and need not terminate in subjectivism where data is regarded as indistinguishable from theory.

framework. Naturally, conclusions drawn from experimental data need to be described with caution lest they be paraded as evidence for *a priori* assumptions.

The point was argued in this section that understandably, researchers of the unconscious have been sceptical of psychoanalytic conceptions of unconscious cognition. The fact that many researchers have shifted to more 'respectable' (or perhaps more researchable) areas such as neuropsychology and cognitive-orientated theories of memory and perception (Jacoby *et al.*, 1992) suggest that there has been acceptance of the notion of the 'unconscious', and that this notion is not synonymous with psychoanalysis. The result is the acceptance of a '*cognitive unconscious* that differs in important ways from the *psychoanalytic unconscious*' (*ibid.*). Erdelyi rightly draws attention to the apparent fact that 'Although the unconscious need not be logically tied to the psychodynamic approach, in practice it usually is' (1992), hence his warning that it should be reclaimed 'gingerly'. This does not necessarily mean that data generated by SPA researchers is 'tainted', or incommensurable, with that generated by experimenters working in other theoretical fields, and Popper's criterion of the demarcation of science from non-science was pointed to as a way of establishing appropriate common ground.

2.5.1 THE SUBLIMINAL PSYCHODYNAMIC ACTIVATION PARADIGM

In this section, a survey of literature which falls into the realm of Subliminal Psychodynamic Activation (SPA) will be presented. Criticisms of the approach will be noted, and discussed.

2.5.1.1 SYMPTOM ENHANCEMENT STUDIES

According to Shulman, Silverman is credited with the development of SPA methodology (1964 in Shulman 1990, p. 489). Silverman's experiments involved tachistoscopically exposing (typically 4 exposures at 4 ms.) various groups of clinical subjects (such as 'stutterers', 'schizophrenics', 'depressives' etc.) to psychodynamically relevant stimuli (relevant that is, to their diagnosed psychopathology). These stimuli were designed to evoke unconscious conflicts in the subjects, or as Weinberger and Hardaway (1990) put it, they were designed to 'stir up libidinal and aggressive conflicts' presumed to underlie psychopathology. The dependent measures were contrived to measure associated changes. The stimuli were either verbal, or drawings depicting various relevant themes. Generally, the results of such studies were positive, and appeared to support the various psychoanalytical formulations.

Numerous examples, which are discussed below, are available of both mixed and positive findings with the use of psychodynamically relevant subliminal stimulation phrases with clinical samples. Talbot *et al.* (1991) found that **both** subjects suffering from anaclitic[5] depression and controls who were exposed (4 ms.) to the experimental phrase 'Mommy is leaving me', ate significantly less crackers in an experimental task, than those exposed to the control phrase 'Mona is loaning it'. It is important to note that the depressed group did not react differently to the control group when exposed to the abandonment stimulus in this experiment and this is inconsistent, as the authors point out, with previous studies (Dauber, 1984; Schmidt, 1981. cited by Talbot *et al.* 1991). Those exposed to the supraliminal experimental phrase tended to eat more crackers in the bogus rating task. Interestingly, this was a relatively large all male group (N=148). These authors suggest that the lowered consumption of food in the anaclitic group exposed to the abandonment stimulus is related to the tendency of the anaclitic personality to engage in denial and avoidance as a defence against conflict. This does not explain the lowered consumption of food in the control group however. It may be, as they point out, that the response of male subjects is different to that of females, but the fact remains that the stimulus phrase did not differentiate clinical from non-clinical groups on the basis of the central behavioural index, and this casts doubt on the validity of their hypothesis. They concede that the abandonment phrase may not have been specifically relevant to the 'needs, wishes, and fears central to the anaclitic personality', and may be salient to all human beings.

These authors also used a measure of 'Confidence in judgement' and 2 measures of 'Confidence in Interpersonal Attractiveness'. They found that in the first measure of 'Confidence in Interpersonal Attractiveness', both the anaclitic and control group exposed subliminally to the abandonment message showed significantly lower levels of confidence than those exposed to the neutral stimulus.

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[5]Anaclitic depression is contrasted with introjective depression whereby the former is thought to be related to an early loss of maternal support, manifesting in pathology and interpersonal difficulties related to 'primitive' conflicts, and the latter is thought to be related to more mature types of conflicts such as guilt and personal unworthiness etc.

Despite the lack of specificity found in their subjects' response pattern (in terms of the subject groups), and hence a lack of support for their psychodynamic hypothesis, these authors' conclusion, that semantic analysis was performed without consciousness appears valid, since there was a qualitatively different response to supraliminal and subliminal exposure of the stimuli. They speculate that the subliminal message bypassed ego defences to activate symptoms (avoidance, denial), while the supraliminal presentations of the stimuli activated defences. They suggest that the increased food consumption noted in the supraliminal condition reflected an 'action-oriented defence against anxiety and an act of self-nurturance' (p. 821).

Dauber (1984) found in a group of depressed women (*N*=18) that subliminal (4 ms) exposure to the phrase 'Leaving mom is wrong' increased depression, but the stimulus phrase 'Mommy and I are one' did not reduce depression. In a second experiment, the stimulus 'Leaving mom is wrong' also increased depression, especially for high scorers on a measure of introjective depression, and the stimulus 'Mommy and I are two' reduced depression on one of the two dependent measures (TAT) at a level close to significance (p=0.054). The dependent measure used in both experiments was a modified version of the Depression Adjective Check List (Lubin 1965, in Dauber, 1984), and the additional dependent measure used in the second experiment was the TAT. Dauber concluded that psychodynamically relevant effects could be shown with subliminal stimuli whose content was relevant to the psychodynamics of the subjects.

In a study of abandonment fear and binge eating, Patton (1992) found support for the theory that binge eating episodes are associated with fear of abandonment in an analogue sample of eating disordered, and non-eating disordered subjects (as measured by the Eating Disorder Inventory: Garner and Olmstead, 1984, in Patton, 1992). Using a double-blind method, Patton found that eating disordered subjects ate significantly more than non-eating disordered subjects in a bogus cracker rating task after subliminal exposure to the stimulus 'Mama is leaving me'. No such effect was found with subjects from either group when the exposure was supraliminal, nor was there any increase when subjects were exposed subliminally to the control phrase 'Mama is loaning it'. Patton interpreted these findings as giving preliminary support for the psychoanalytic hypothesis that binge eating is a defence against an unconscious fear of abandonment.

2.5.1.2 SYMPTOM REDUCTION STUDIES

After initial research with stimuli calculated to stir up unconscious conflicts, Silverman went on to explore the use of subliminal stimuli which were designed to activate symbiotic fantasies (eg. 'Mommy and I are one') and achieve a decrease in pathology. These symbiotic fantasies were found to ameliorate symptoms in a broad range of both clinical and non-clinical groups.

Findings by other researchers were thought to corroborate certain psychoanalytic propositions. In their article, Gustavson and Källmén (1990) cite Silverman's (1982) review of these studies, and mention important positive findings. In an experiment, high school students' classroom behaviour and academic performance improved after exposure to a subliminal symbiotic message (Bryant-Tuckett and Silverman, 1984, cited by Gustavson and Källmén, 1990). Following exposure to a symbiotic message, patients were more easily able to give up smoking (Palmatier and Bornstein, 1980, cited by *ibid.*), and alcoholics were able to reduce their drinking (Schurtman, Palmatier and Martin, 1982, cited by *ibid.*). In their own research, Gustavson and Källmén showed that when subjects were exposed to a subliminal symbiotic phrase ('Mommy and I are one'), cognitive and motor performance was improved compared to subjects exposed to a neutral phrase ('People are walking'). The improvements resulting from exposure to the symbiotic stimulus are typically explained by the theory that a child's separation from a mother figure is accompanied by unconscious anxiety and insecurity. Associated with this separation is an unconscious wish to return to the security of the symbiotic state with the mother figure. This wish however, is in direct conflict with the socialised superego which forbids such a shift. Exposing subjects to a subliminal suggestion of symbiosis is thought to bypass the superego, and the unconscious wish is fulfilled by means of a symbiotic fantasy - thereby reducing anxiety and improving performance.

2.5.1.3 EVALUATION OF SPA RESEARCH

In this section, SPA research will be discussed in terms of various criticisms and the answers to these criticisms. The emphasis will be on a broader view of the validity of SPA research.

2.5.1.3.1 FUDIN AND BENJAMIN (1992)

Although the literature surveyed thus far all showed positive findings, there are a substantial number of failures to replicate them. In summarising their list of experimental results, Fudin and Benjamin (1992) concluded that the majority of experiments do not clearly support SPA hypotheses. These authors categorised the results of published research using the guideline that a judgement of whether the findings of the experiments were supportive of SPA or not should be based simply on the result of hypothesis testing. They established their criteria in the following manner:

1. If at least half of the hypotheses advanced in an experiment were supported, the investigation would be judged 'clearly supportive'.
2. If any hypothesis was supported on any measure, the results were classified in a 'middle group' - these studies could be thought of as 'weakly supportive'.
3. Results in which no hypotheses were supported, or if the results were significant but in the opposite direction to that expected, were categorised as 'non-supportive' (Fudin and Benjamin 1992, p. 962).

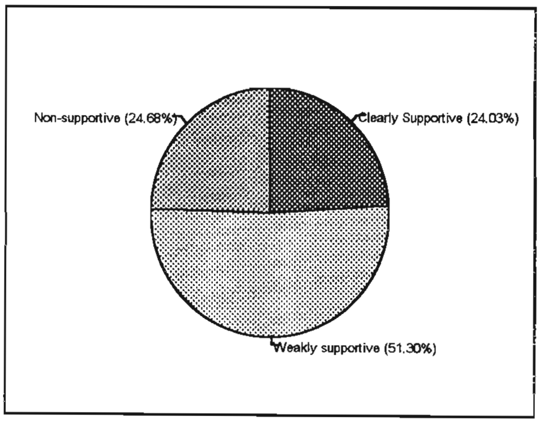

Figure 2.1 Survey of findings (Fudin and Benjamin, 1992).

The results of their review are illustrated in Figure 2.1. The largest proportion (51.30%) of their findings were weakly supportive (79 studies), followed by the non-supportive findings (24.70%, 37 studies), which was closely followed by those which were supportive (24%, 37 studies). If one takes the supportive and weakly supportive findings, it could be said with some legitimacy that the majority of the studies lent **some** support to SPA, even if such support is weak. Included in the group of studies which Fudin and Benjamin judged non-supportive are some where results were opposite to those predicted but were statistically significant. While these results clearly do not confirm the hypotheses, they still do not constitute a null finding. If one sees this less conservatively, these results may be valid experimental findings. Results which are opposite to predictions are still meaningful, and constitute a comment of some kind on the hypothesis in question.

Given the data presented above, these authors' judgement that the majority of findings do not clearly support SPA hypotheses may be overly conservative. A general dismissal of SPA methodology on the strength of the above findings is unwarranted, since the majority of them could be seen to lend it some support, even if it is modest. The contention that SPA effects are highly specific with regard to the nature of the stimuli employed, the dependent measure, and the psychodynamic characteristics of the subject sample needs to be highlighted. Dauber (1984) makes this same point in his comment that investigators should take more care to finely delineate their subject populations than they have done in the past. Otherwise, Dauber argues, justice is not done to either the research method, or psychoanalytic theory. This comment seems appropriate given the guideline suggested earlier, that hypotheses should be precise, narrow and specific.

Despite some successes in finding support for psychoanalytic hypotheses, this approach has been heavily criticised. Criticisms are levelled at SPA research on methodological, statistical and theoretical grounds.

2.5.1.3.2 BALAY AND SHEVRIN (1988)

In particular, Silverman's research has been subjected to extensive criticism eg. Silverman and Candell (1970: *On the relationship between aggressive activation, symbiotic merging, intactness of body boundaries, and manifest pathology in Schizophrenics*); Silverman *et al.*(1972: *The effects of subliminal drive stimulation on the speech of stutterers*); Silverman *et al.* (1973: *An experimental study of aspects of the psychoanalytic theory of male homosexuality*); Silverman (1978: *Simple research paradigm for demonstrating subliminal psychodynamic activation: Effects of oedipal stimuli on dart throwing accuracy in college males*) - these studies cited in Balay and Shevrin, (1988).

Balay and Shevrin (1988) offer the following general criticisms of Silverman's work:

1. Problems with experimental design and control.
2. The lack of consistency and robustness of Silverman's claimed effects.
3. The inconsistencies of Silverman's results in relation to SPA methodology and the psychoanalytic propositions which Silverman researched.

These criticisms will be described briefly.

Firstly, a number of methodological difficulties are given. In many of his experiments, Silverman had difficulty in establishing the neutrality of both neutral and control stimuli, a difficulty which was largely ignored. This is problematic since the neutrality of control stimuli cannot simply be assumed, as Balay and Shevrin point out. They cite a study by Litwack, Wiederman and Yager (1979) in which it was found that Silverman's supposedly neutral stimulus, 'people are talking', was not seen to be neutral by a group of schizophrenic subjects. The phrase elicited the association in these subjects that 'people are talking about me'. There also been general difficulty in establishing the validity of the stimuli which Silverman used in terms of the construct being tested. Balay and Shevrin ask the following germane question:

> For instance, if a subliminal picture of a charging lion increases a pathological-thinking change score as compared to the critical control picture of a bird, is that because of the aggressive qualities of the experimental stimulus, because of some unknown meaning the bird has for the subjects, or because of some unknown interaction between the baseline control pictures and the experimental stimuli? (p. 162).

Another difficulty involves Silverman's use of two types of controls, i.e. both a baseline and critical control paired with the experimental stimulus. The difficulty involves the lack of counterbalancing in the order of baseline and critical conditions with regard to the baseline controls. Because of this, Balay and Shevrin argue that results 'cannot be generalised beyond the interaction of baseline and critical conditions' (p. 162).

Silverman is also criticised for the excessive use of *post hoc* and *ad hoc* explanations, and auxiliary hypotheses which are not validated by any further research. An example Balay and Shevrin give of an auxiliary hypothesis involves Silverman's 'index of homosexual orientation' derived from ratings of sexual attractiveness of male and female photographs. This index was used without any attempt at validation. While these authors acknowledge the difficulty involved in operationalising and researching these constructs, they criticise Silverman for continuing to expand the applications of his theory while ignoring difficulties of this kind. Silverman tended to proceed regardless of experimental inconsistencies, and without testing the *post hoc* hypotheses which were formulated to explain them. Balay and Shevrin suggest that by doing so, Silverman tended to ignore difficulties in his basic theory.

Secondly, the results which Silverman reported were by no means robust, and a number of attempted replications have failed. Silverman himself also had difficulty in replicating some of the experimental successes. This happened in the case of Silverman's study of stuttering where an exact replication of the earlier results was not achieved. Silverman also failed to replicate a study of competitive behaviour and oedipal conflict involving dart throwing as a dependent measure. A notable failure to replicate cited by these authors is Heilbrun (1980) in which care was taken to replicate the exact conditions of Silverman's original study (Silverman *et al.*, 1978, in Balay and Shevrin, 1988). Although the experiment was repeated twice, each time with refinements to bring it closer to the original experiment, no effect was found. According to Balay and Shevrin, Heilbrun was at a loss to explain these findings from a methodological point of view, and was forced to conclude that SPA effects were not at all robust.

Thirdly, Silverman's theoretical assumptions have been questioned with regard to the use of the supposedly ubiquitously therapeutic (symbiotic) phrase 'Mommy and I are one'. Balay and Shevrin dispute Silverman's claim that this is universally relevant by suggesting that fantasies of oneness are experienced, expressed and understood idiosyncratically. For some individuals, they argue, a fantasy of symbiotic oneness might have been experienced on 'Mommy's lap', in which case the experimental phrase 'Mommy's lap' would be more potent. One can certainly see the logic of this argument, and it seems possible that cultural differences could be an important factor. For example, the authors point out that in the South, usage of the term 'Mama' is more prevalent than in the northern parts of the United States. Given that this is a likely factor, one could then reason that idiosyncratic factors and differences in life experience are also determinants of response to any given symbiotic stimulus phrase. Ultimately, this ought to become a research question which is operationalised and tested.

2.5.1.3.3 WEINBERGER AND HARDAWAY'S (1990) REBUTTAL

A larger list of criticisms is given by Weinberger and Hardaway (1990) who also attempt to answer them. Some of these objections will be presented and discussed.

1. Primary analyses of data. A) Gain scores have been used instead of final status and covariate adjusted scores. B) Silverman and other authors have often been accused of using one-tailed tests of significance.

Weinberger and Hardaway answer these objections by pointing out firstly, that the use of change, or gain scores is probably appropriate in the case of within-subjects designs in SPA methodology since the ANCOVA has a tendency to under adjust for the pre-treatment score, whereas the difference score has a tendency to over adjust for the pre-treatment score. This, Weinberger and Hardaway suggest, is desirable since the danger of under-adjusting for pre-treatment scores is worse than the danger of over-adjusting in SPA research. In cases where there is a high correlation between pre- and post-treatment scores, the use of difference scores is justified. In addition, these authors point to the fact that meta-analyses of SPA research which report genuine effects for much of the research, have used measures which are not vulnerable to the gain-score criticism.

Secondly, These authors point to the general controversy about the use of one-tailed versus two-tailed tests of significance. In practical terms, conversion from a one-tailed to a two-tailed test of significance is easily done by doubling the probability level, although the probability of making a Type I error is increased (i.e. retaining H_a instead of H_0). On the other hand, these authors argue that levels of significance are a question of convention, and do not have any necessary logical or scientific basis. As Weinberger and Hardaway remark, on occasion statisticians have intimated that psychologists worry too much about Type I errors and not enough about Type II errors (Cohen, 1977; Hunter *et al.*, 1982; Rosenthal and Rosnow, 1984, cited by Weinberger and Hardaway, 1990), and given the somewhat arbitrary nature of $p<0.05$, this concern has substance especially in areas of research where effect sizes are generally small.

2. File-drawer argument. This argument states that there may be a large body of unreported negative results that 'languish in filing drawers' and which lead to the impression that SPA findings are more consistent than is the case in reality.

Weinberger and Hardaway respond to this argument by pointing out that many of the studies on SPA were doctoral dissertations, and state that these are published whether they report negative or positive outcomes. Their analysis of the *fail-safe N* statistic[6] suggests that further validation of the aggressive and libidinal drive studies is needed, while the oedipal sanctioning and symbiotic studies appear robust with respect to the probability of the number of existing null filing drawer studies.

3. Failures to replicate. Weinberger and Hardaway acknowledge that there have been some replication failures, but suggest that some of them were not valid replication attempts. They offer detailed criticisms of some of these failed replications. In the case cited by Balay and Shevrin (Heilbrun, 1980: failed replication of symbiotic oneness studies), Weinberger and Hardaway point out deficiencies of Heilbrun's procedure, one of which was the viewing distance of the tachistoscope which was 30 cm less than that of Silverman *et al.* (1974) and which altered viewing angles by 10 to 30%. Weinberger and Hardaway suggest that this factor may have been responsible for the failure to replicate, since subjects may not have been able to see the stimulus. One of their conclusions, based partly on invalid failures to replicate, is that Silverman and his colleagues were not more likely to obtain effects than independent investigators. They base their conclusion on a sample of the results of research gathered in 1985. In this sample, they show that of the 59 supportive studies, 33 were connected to Silverman in some way, and 26 were conducted independently of him.

Weinberger and Hardaway suggest that inconsistent outcomes may sometimes be due to a lack of statistical power. For instance, if one takes the average power (0.31, one-tailed) of the symbiotic oneness studies (where $\alpha=0.05$) using the average sample size of the studies ($N=36$) then the probability of making a Type II error is 0.69. With a two-tailed test, power is reduced to 0.21, and statistically non-significant results can be expected 79% of the time (p. 741). Periodic failures in replication can therefore be expected due to a lack of statistical power. Weinberger and Hardaway conclude that 'blanket indictments cannot be legitimately levelled because of isolated failures to replicate' (p. 741). They also conclude that meta-analysis is

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[6] This method entails an estimation of the number of studies averaging null results, and the determination of the number of studies it would take to annul a given number of positive findings. The *fail-safe N* statistic reflects the number of studies showing null results that would bring the probability of a body of research to $p=0.05$. If the *fail-safe N* is large enough, the filing drawer criticism is regarded as invalid.

required for the whole corpus of results to be analysed systematically. The results of their meta-analysis suggest that while there appears to be a significant laboratory bias in SPA effects for 'libidinal-drive derivative studies' and 'oedipal-prohibiting studies', no such bias exists in the Oedipal and adaption-enhancing studies. Moreover, they demonstrate from the meta-analysis that there are substantive effects in SPA research for oedipal and adaption-enhancing stimuli.

4. Subliminality. As Weinberger and Hardaway comment, the question of subliminality is a thorny one. The main problem in this area it seems, is a lack of consensus on what constitutes subliminality. Cheesman and Merikle (1984) suggest that subliminal effects are observed at the higher subjective awareness threshold (see section 2.6.1). Weinberger and Hardaway do not resolve the definitional difficulties, but assert that an acceptable set of criteria regarding subliminality are generally agreed upon and met in SPA research.

It is indeed difficult to establish whether authors have adequately ensured the subliminality of their stimuli. It seems that most authors have used an exposure time of 4 ms using unmasked stimuli on a tachistoscope (see Bornstein, 1990, Bornstein, 1992; Dauber, 1984; Masling *et al.* 1991; Patton, 1992). This appears to have become a rule of thumb. Some authors go to great lengths to establish that the stimuli were not consciously detected by their subjects. For example Masling *et al.* 1991, used 3 separate tests of awareness: 1. An open-ended recall test. 2. A multiple choice recognition test. 3. Tests in which subjects were asked to discriminate between control and experimental stimuli exposed at 4 ms. These authors had positive results in their experiment. Dauber (1984) also asked subjects to choose between control and experimental stimuli exposed at 4 ms. As a test of awareness, Patton (1992) required subjects to choose between control and experimental stimuli in a list of phrases, and found that their selection of targets did not exceed the level of chance. While absolute assurance cannot be given, generally, the impression was gained from the literature which was consulted, that the authors went to great lengths to ensure subliminality of their stimuli.

Bornstein (1992) regards stimulus unawareness as a crucial factor for the production of SPA effects. Although he remarks that some authors have 'not assessed subjects' awareness of 4-ms stimuli as rigorously as possible' he implies that subliminality was generally achieved, from the fact that differential effects were found between subliminal and supraliminal exposure conditions. He points to 43 studies in which there was a comparison between these two conditions, and shows that statistically stronger effects were likely to occur in the subliminal condition (in the theoretically predicted direction) at a rate significantly higher than chance (χ^2=7.54, df=1, N = 43, p=0.006). Bornstein also found evidence for this in his meta-analysis of SPA studies (1990, cited in Bornstein, 1992). This indicated that significantly stronger effects on behaviour occurred when stimuli were presented subliminally. This argument may seem to be somewhat circular because when Bornstein attempts to infer that subliminality was achieved from the finding that differential effects occurred between conditions, he seems to be assuming what he is trying to prove. Although he has not established in the first place that the exposure conditions were different, it seems reasonable to make this inference (backwards) from the fact that different effects were obtained between conditions. His argument is perhaps not viciously circular.

5. Expectancy and demand characteristics. Weinberger and Hardaway reply to the criticism that SPA effects are due to experimenter effects, and the demand characteristics of the experimental situation by pointing out that SPA studies are carried out in a *double-blind* fashion. True double-blind studies are rare in psychology, as these authors remark, and are a strong guarantee both that the experimenter cannot systematically influence a subject's response, and that the subject cannot guess the direction of the expected effect. This seems to be an adequate answer to the criticism.

6. The problem of inference. These authors acknowledge that the (unconscious mental) events which mediate between the stimulus and behavioural response have only been inferred, and concede that it constitutes a serious problem for SPA. Indeed, this is a thorny question which can scarcely be answered since the events are by definition unconscious. It seems likely that events such as these can only be inferred from behavioural, or perhaps electrophysiological changes. It would be exceedingly naive therefore, to suppose that unconscious events could ever be directly observed, or for that matter, to think that any psychological process can be directly observed without making inferences of some kind. However, the various measures from which inferences are made need to be validated as far as it is practically possible, in order that the inferences made are defensible.

7. There is some agreement that non-psychoanalytic interpretations of SPA findings are poor, and Weinberger and Hardaway concede that rejection of these interpretations does not constitute support for psychoanalytic theory. This draws attention to the argument made previously that findings should, in principle, be able to stand on their own and not be completely dependent on an elaborate and unverifiable theoretical superstructure, although it is obviously necessary for experiments to have theoretical underpinnings and implications. It seems important, if an impasse due to theoretical incommensurability is to be avoided, that findings should lead to theoretical refinement and new syntheses. This would necessitate the use of well established criteria and definitions. Consensus therefore needs to be reached on operationally precise definitions of what constitutes an unconscious process. On the other hand, it is easy to formulate theoretical criteria so rigidly that empirical demonstrations of such phenomena are rendered impossible *a priori*. This makes dialogue and co-operation across tradition theoretical lines all the more necessary, and necessitates the use of well validated and defensible measures.

2.5.2 DISCUSSION

In this section, discussion of the SPA paradigm is summed up briefly. The concepts of 'subliminal perception' and 'unconscious' processes are both extremely controversial, as are psychoanalytic constructs. Any discussion of SPA is therefore bound to be encumbered by controversy. SPA research faces a major problem in establishing the nature of the unconscious processes which mediate between a subliminal stimulus and behavioural output, and this is a problem which leads, at present, to a major impasse. It is not known how in principle, this could ever be established, but one can nevertheless remain open to the possibility that more direct and defensible dependent measures can be developed in order to demonstrate the nature of mediating processes[7] and make inferences more acceptable. Critics of SPA however, tend to fix criteria so rigidly that detection of unconscious processes seems to be rendered impossible *a priori*, and this poses a major problem with regard to operationalising variables.

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[7] Masling *et al.* (1991) for instance, found significant changes in skin conductance and respiration rate, in subjects who were exposed to the experimental phrase 'No one loves me' and concluded that emotionally relevant stimuli perceived without awareness have predictable, measurable effects on autonomic arousal.

Debate concerning the replicability of SPA effects is vigorous, although some of these criticisms may be answered satisfactorily (eg. the filing drawer argument). However there appear to have been some genuine failures to replicate Silverman and others' work. This is a point which Weinberger and Hardaway (1990) concede. It seems that SPA effects are highly specific though, and there may be specific nuances which replication studies did not reproduce. Some replication studies appear to have involved rather arbitrary judgements of significance and have been considered failures when in fact their findings were very close to $p<0.05$. For example Hayden and Silverstein (1983) judged their replication attempt a failure on the basis of $p<0.06$, $t=2.031$, two-tailed (in Weinberger and Hardaway, 1990, p. 737). Weinberger and Hardaway cite a number of similar examples which they consider to be overly conservative judgements.

The criticism that supposed SPA effects are actually due to experimental expectancy effects and demand characteristics, is adequately answered by the fact that SPA research employs double-blind methodology.

The following points can be made in summary of the SPA literature.

1. While there are theoretical and methodological difficulties with the findings of SPA research, enough evidence exists to support the conclusion that SPA effects exist, and are modest in size, and probably highly specific with respect to the properties of the stimuli in relation to the psychodynamic issues relevant to the subjects. The nature of the claims made for these effects is problematic however, and the claimed connections between the subliminal stimulus message and behavioural response are often disputed.

2. Bornstein's seemingly robust finding of different effects between the subliminal and supraliminal exposure conditions is important. In an analysis of 43 studies Bornstein found that there are likely to be **no experimental effects** when stimuli are viewed in the above threshold exposure condition, but when stimuli were exposed below the perceptual threshold, effects were observed. This was confirmed in a meta-analysis which found significantly stronger behavioural effects when stimuli were presented subliminally. These findings led Bornstein to claim that unawareness was crucial for the production of SPA effects.

3. The conclusion of Fudin and Benjamin (1992) that the majority of experiments do not clearly support SPA hypotheses, while technically correct, appears to err on the conservative side since it ignores a considerable number of positive findings for experimental hypotheses in their middle and non-supportive groups.

4. The criticisms of Balay and Shevrin regarding problems with experimental design and controls, lack of consistency and robustness of Silverman's claimed effects, and theoretical inconsistencies, appear less damning in the light of Weinberger and Hardaway's counterarguments. In particular, these authors' meta-analysis, along with those of other authors (Eg. Bornstein, 1990) appears to support the conclusion that reasonably robust and reliable SPA effects exist without needing to resort to problematic statistical tests and levels of significance.

Another quantitative review and meta-analysis by Weinberger and Hardaway (1990) of symbiotically activated fantasies found that after correction for statistical artifacts, small but significant effects were present. Hardaway suggested that further research designed to replicate the experimental design and effects was superfluous.

5. The question of thresholds cannot be settled beyond all doubt, but it is likely that many SPA researchers were able to establish that stimuli presented in the subliminal condition were undetectable.

In short, SPA research has made an important contribution to research on perception without awareness, and evidence exists that specific behavioural changes may be evoked by certain subliminal stimuli. Explanations given for these behavioural changes lack specificity and empirical support however, and links between subliminal stimuli and the experimental effects need to be further elucidated (eg. the general therapeutic usefulness of the symbiotic oneness stimulus 'Mother and I are one'). This author suggests that these links need to be carefully investigated with a view to producing a greater degree of theoretical integration.

2.6 THE NON-PSYCHOANALYTIC RESEARCH PARADIGM

It was pointed out earlier that there is no necessary connection between research into subliminal perception and psychoanalysis. This point is important since the explicit aim of SPA is to test specific psychoanalytical propositions, whereas research in this area is concerned with a wider range of non-clinical phenomena. In this section, important research will be surveyed, and the conclusions and implications discussed.

2.6.1 SEMANTIC PRIMING

Many studies of unconscious perception have been done in which primes (usually words) are presented tachistoscopically to subjects below the perceptual threshold. This is done as a way of researching the aspects of visual perception which occur without awareness. The discussion will begin with the question of thresholds, since this is crucial in understanding the research.

It must be pointed out from the outset that one of the most problematic issues in this area is the question of thresholds. There is sharp debate on the question of stimulus thresholds and measures of awareness in the 'perception and cognition without awareness' literature, although in recent years, some consensus has been reached on the basis of Cheesman and Merikle's (1984) definition of two threshold levels:

1) A subjective threshold is the detection level at which 'subjects **claim** not to be able to discriminate perceptual information at a better than chance level' (p. 391).

2) An objective threshold is 'the detection level at which perceptual information is **actually** discriminated at a chance level' (*ibid.* bold type added for emphasis).

Greenwald *et al.* (1995) clarify this in a helpful manner by suggesting an operational definition of each:

1) A subjective threshold is associated with 'greater stimulus energy', and is also likely to be associated with above-chance performance on direct measures. Essentially it is the highest level of stimulus presentation at which subjects report **phenomenal lack of awareness**.

2) An objective threshold is the highest level of stimulus energy at which 'forced-choice responding indicates that the stimulus is undetectable' (*ibid.*). This signifies that performance is at the level of chance in a direct test of detection.

Questions are often raised concerning the subliminality of stimuli in the early studies of semantic priming without awareness. In their criticism of a previous experiment (McCauley, *et al.*, 1980, cited by Purcell *et al.*, 1983) which used backward masked semantic primes, Purcell *et al.* dispute the claim that the primes were presented below the threshold for identification, and hence the claim that semantic priming without awareness occurred. They suggest in the case of McCauley *et al.*, who in their view produced some of the most convincing evidence of semantic priming without awareness, that the priming information was actually available to subjects because of light adaptation. They concluded therefore, that this claim of sematic processing without awareness was premature.

Cheesman and Merikle (1984) also failed to obtain priming effects when their exposure threshold was based on an objective test of awareness (subjects are not able to distinguish between targets and non-targets in a forced-choice test at a greater than chance level).These authors however, were able to show priming effects when a subjective threshold was used. They argue that the effect of masking is to reduce subjective confidence that a stimulus has been presented, and in this situation, subjects may show discriminative responding although they are not able to report having seen the stimulus. In terms of Cheesman and Merikle's findings, this is likely to be an explanation of why Purcell *et al.* failed to obtain priming effects in their experiment, since they set their threshold at the objective level. It is thus possible that the findings of McCauley *et al.* are quite valid, assuming that the subjective exposure threshold was used.

A later study of unconscious semantic processing was conducted by Groeger (1984) which investigated the effect of priming on word recognition. Subjects were required to choose a response (in a forced-choice manner) from a matrix of 24 words which were either structurally or semantically related to the subliminal target. The matrix of words was made up as follows: 6 were semantically related to the target, and the remaining 18 had some structural similarity to the target. Groeger established awareness and recognition thresholds for each subject and each target in a preliminary experiment. The average awareness threshold was in the region of 10 ms, and recognition thresholds fell between 37 ms and 59 ms. Subjects were exposed to stimuli at these two levels, and were then asked to select the word they thought they had seen from a matrix of words. The words in the matrix were either structurally or semantically related to the stimulus word.

Groeger concluded that the data supported the views of subliminal perception theorists, i.e. that unconscious semantic processing occurred. Subjects exposed to primes that were below recognition threshold chose words that were structurally related to the target, i.e. structural or graphical analysis occurred and predominated in word choice. Subjects exposed to primes that were below the awareness threshold chose words that were semantically related, i.e. semantic analysis predominated in word choice.

Marcel (1980, cited by Marcel, 1983. N.B. in all cases, Marcel 1980 is cited by Marcel, 1983) conducted an experiment in which subjects were exposed to polysemous[8] words which were shown to subjects in either a masked or unmasked manner. Preceding presentation of the polysemous word was a context word, and after presentation of the polysemous word was a third (target) word. For example, one of the sequences used was:

1. HAND (context or biasing word)
2. PALM (polysemous word: either a type of tree, or a part of the hand)
3. WRIST. (target word)

Marcel found that the masked presentation of the word 'PALM' facilitated processing of the word 'WRIST' irrespective of the preceding context word, whereas the unmasked presentation of the word 'PALM' only facilitated processing of the word 'WRIST' when the preceding context word was 'HAND'. Presentation of the priming word 'TREE' delayed processing of the target word 'WRIST'. Marcel used decision time to target as a dependent measure.

The conclusion of this experiment was that conscious awareness is necessary for the selection of a context-relevant interpretation of a stimulus. While the context word activated **one meaning only** of the polysemous word in the unmasked condition, **both** were activated when exposure to the polysemous word was masked. Thus, as Merikle (1992) expresses it, 'context exerts relatively few constraints when words are perceived without awareness, but conscious awareness is necessary for the selection of context-relevant interpretation' (p. 794). The significance of this result is that a qualitatively different effect was shown between conscious

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[8] A *polysemous* word has more than one meaning, which are all spelled the same (distinct from a *homophone* whose various meanings sound the same, but are spelled differently).

and unconscious conditions, hence Marcel considered that a difference between conscious and unconscious cognition had been demonstrated.

2.6.2 WORD DETECTION, GRAPHIC AND SEMANTIC ANALYSIS

In a further series of studies, Marcel (1983) showed that as word-mask stimulus onset asynchrony[9] (SOA) was reduced, subjects reached chance-level performance on the detection, graphic, and semantic decisions in that order. A dioptic[10] method of pattern masking was used in this experiment. A corollary of this finding is stated by Doyle and Leach (1988), that 'there is semantic activation at short SOA's which is more useful to subjects than graphic information in making similarity judgements (p. 289). In other words, semantic judgements could be made about stimuli, even when presence/absence judgements about stimuli were at chance level, thus providing evidence of semantic processing at short SOA's.

In a review of visual masking studies, Doyle and Leach (1988) re-examined and re-analysed the results of various replications attempted in the following experiments:

1) Marcel (1983), experiment 2
2) Fowler *et al.* (1981)
3) Nolan and Caramazza (1982)

Marcel (1983) tried to replicate his original demonstration (1980, in Doyle and Leach, 1988) that a semantic judgment could be performed when the presence/absence judgements about stimuli were at chance level, but appeared to be unsuccessful. However, Doyle and Leach's reanalysis of the experiment show that subjects were still able to discriminate better on the basis of semantic similarity than graphical similarity under these conditions. The results of a *t*-test are significant ($p<0.05$, one-tailed) when subjects' choice of semantically similar words is compared with their choice of graphically similar words (35.6% vs. 29.4%). As a replication,

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[9] SOA refers to the duration between the onset of the target exposure, and that of the mask in backward masked experiments. It could be thought of as the effective exposure time.

[10] In dioptic exposures, stimuli are presented separately to both left and right visual fields, usually with specific modifications. This method is distinct from the binocular method, where stimuli are presented to both visual fields simultaneously.

Doyle and Leach suggest that a one-tailed test of significance is appropriate.

In the case of similar work by Fowler *et al.* (1981, in Doyle and Leach, 1988), Doyle and Leach suggest that evidence for semantic activation was overlooked. In their second experiment which implemented a control condition (in which subjects were not exposed to any masked stimulus), the size of the bias (in favour of subjects choosing correct targets) when there was no stimulus present, was not compared with the size of the effect when the stimulus was present since the authors only tested against the 50% level of chance. In re-analysing the data, Doyle and Leach conclude that evidence existed which was overlooked, of semantic processing at SOA's for which subjects cannot make visual judgements of similarity above the level of chance.

Thirdly, in their study, Nolan and Caramazza (1982, in Doyle and Leach, 1988) did not compare the results of semantic judgements between the groups of subjects who were exposed to a stimulus to those who were not. Semantic judgements were superior to visual judgements at the low presence/absence detection level, but the difference was not statistically significant (58% vs 55 %). However, differences which approach statistical significance (p=0.12, two-tailed) can be seen between the two groups in terms of semantic judgements (58% correct when the stimulus was present vs. 50% correct when it was absent). These conclusions seem somewhat tenuous, but Doyle and Leach suggest that since 2 subjects (who were excluded from the analysis because of their detection scores of >60%) performed significantly better in the semantic judgements than the visual similarity task, additional corroborating evidence exists for semantic activation at short SOAs. Again, this conclusion seems precarious.

Doyle and Leach conclude (perhaps a little optimistically) that the studies reviewed provide ample evidence of semantic activation at short SOAs where detection is at the level of chance. The claim made by Marcel that semantic similarity judgements would be superior to those of presence/absence was not clearly supported though.

In their own research, Doyle and Leach found that at short SOA's, words were more detectable than non-words. They term this a 'word superiority effect', and concluded the following:

1. High level processing (lexical access, as opposed to graphical analysis) occurs for short target-mask SOA's when subjects have considerable difficulty detecting the target.

2. Because words are more detectable than non-words, lexical activity affects levels of detectability.

In two further experiments, Doyle and Leach replicated this effect, and refined a number of hypotheses related to the detectability of words in terms of their orthographic structure.

Another experiment which replicated and confirmed the experimental findings of Doyle and Leach was done by Hirshman and Durante (1992). In their first experiment, they showed that while masked prime-presentation durations of 33 ms produced near-zero identification rates, the semantic priming effect was approximately as large in the masked prime condition as in the control (above threshold) condition. Hirshman and Durante replicated this finding in an identical experiment, and reported similar findings, i.e. that targets preceded by related primes were responded to faster than targets preceded by unrelated primes.

Hirshman and Durante draw the following conclusions from their work:
1) The finding that semantic priming can occur without prime identification 'raises important questions about the sufficiency of theories which assume that conscious retrospective semantic matching occurs' (p. 263).
2) The finding that semantic priming can occur in the absence of identification suggests, that 'semantic activation can occur before word identification' (p. 264). This finding agrees with that of Groeger (1984), Doyle and Leach (1988) and numerous others (see Hirshman and Durante, 1992, p. 264).

Amongst other things, this finding has important implications for theories of word recognition, and especially for theories of subliminal perception. Hirshman and Durante suggest 'that an item's semantic characteristics may affect the latency or accuracy of its identification' (*ibid.*), a suggestion made too by Balota (1990, in Hirshman and Durante, 1992). Although this could simply reflect issues of word complexity and recognisability, it is also suggestive of the notion of perceptual defences[11], although this notion as operationalised by the Defence Mechanism Test (DMT) designed by Kragh (1985, cited by Bengtsson, 1991) and used for example, by Sundbom *et al.* (1989), appears on first impressions, to be rather remote from Hirshman and Durante's observation.

Sundbom *et al.* showed a relationship between the borderline personality disorder and specific perceptual distortions measured by the subliminal DMT. Bengtsson (1991), another researcher in this area, suggests that 'stimuli which do not achieve conscious representation may still influence conscious psychological processes' (p. 38). Despite the fact that this observation has become something of a cliché in the literature, when seen in the light of Hirshman and Durante's suggestion, it appears more plausible. Bengtsson remarks that 'the findings from several lines of research strongly suggest that pre-conscious processing involves complex cognitive activity, including, among other things, semantic analysis and an emotional appraisal of sensory inflow...' (*ibid.*). This remark naturally suggests a number of interesting avenues for exploring psychodynamically orientated hypotheses.

Bengtsson suggests that the emotional classification of sensory inflow that takes place outside of awareness influences its chance of achieving phenomenal representation. Specifically, Bengtsson submits that when the 'perceptual threshold for an emotionally loaded stimulus is raised compared to a more neutral stimulus, the effect may be interpreted as a manifestation of the defence mechanism of repression' (*ibid.*). This is similar to Dixon's view (see footnote 11). The Subliminal Psychodynamic Activation (SPA) literature is certainly replete with examples of behavioural changes which occur in response to specific stimuli, and these may be related to the phenomenon of differential semantic processing. Whether these phenomena can be equated with defensive operations though, is a subject which requires careful consideration. Unfortunately, drawing parallels between semantic analysis and defensive operations raises further problems and goes beyond the scope of the research discussed in this review.

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[11] The existence of perceptual defences is inferred from the finding that different stimuli (verbal and pictures) have different sensitivity thresholds. Dixon (1991) states that 'subjects show abnormally high or low thresholds for words related to underlying complexes' (p. 245).

2.6.3 THE MERE EXPOSURE EFFECT

This refers to the finding by Zajonc (1968, in Bornstein and D'Agostino, 1992; Murphy and Zajonc, 1993) that 'repeated, unreinforced exposure is sufficient to enhance attitude towards a stimulus' (*ibid.*, p. 545). This finding has been shown to be robust, and reliable.

2.6.3.1 CONDITIONING BY MEANS OF UNDETECTED STIMULI.

Another effect consistent with the findings cited and discussed previously in relation to unconscious semantic processing (Groeger, 1984; Marcel, 1980, in Marcel, 1983; Doyle and Leach, 1988; Hirshman and Durante, 1992, p. 264) is that termed the *mere exposure effect*, observed in below threshold exposures. Research into the mere exposure effect has thus been extended by presenting conditioning stimuli subliminally, with the result that stronger conditioning effects have been found for subliminal presentation than for above threshold presentation. Indeed, Bornstein's (1989) meta-analysis of subliminal mere exposure experiments concluded that 'across all mere exposure experiments, there is an inverse relationship between stimulus recognition accuracy and the magnitude of the exposure effect' (in Bornstein, 1992, p. 545).

In their 1992 study, Bornstein and D'Agostino replicated this finding in two experiments with subliminal (5 ms) and above threshold (500 ms) exposures to various stimuli (Welsh figure, and a photograph). Both experiments showed evidence that the mere exposure effect was stronger in the subliminal condition than when stimuli were clearly recognised.

Another study which deserves mention, is that by De Houwer *et al.* (1994) who used a method of backward pattern masking on a 70 Hz *VGA* computer screen linked to a 486 computer. These authors presented neutral words (CS), followed by a below threshold exposure of either a positive or negative word (US) and found that subjects exposed to positive stimuli liked the neutral words more than those exposed to a negative stimulus. They concluded that evaluative conditioning can occur in the absence of contingency awareness.

2.6.4. PREATTENTIVE BIAS STUDIES

A number of investigations were conducted by Mogg *et al.* and Bradley *et al.*, into the subliminal processing of information with subjects suffering from anxiety and depression, and also with non-clinical subjects. These authors set out to investigate Beck's theory that mood-congruent biases 'operate throughout all aspects of processing, such as attention, reasoning and memory' (Mogg, *et al.* 1993, p. 304). Their studies also sought to research the effects of anxiety and depressive conditions on pre-conscious processing of information. This involved testing for perception without awareness in relation to hypothesized bias thought to exist in early stages of information processing (which occur without awareness). According to Beck, anxiety and depression vary with the type of processing bias encountered (Beck, 1976, Beck *et al.* 1986). Anxious individuals, according to this theory, process anxiety-relevant information, whereas depressed individuals selectively process depression-relevant information (Mogg *et al.* 1993). Some studies have found evidence that anxiety is associated with a bias in early aspects of processing (attention) (Matthews, 1990, provides a review of these studies), whereas depression is associated primarily, with a bias in later stages of processing (Mogg *et al.* suggest Dalgleish and Watts, 1990; Macleod, 1990; Williams *et al.*, 1988 for reviews of these studies).

Williams *et al.* (1988, in Mogg *et al.*, p. 304) proposed that with anxiety, the bias operates at an 'automatic, preattentive stage' (*ibid.*) and anxious individuals direct processing resources towards negative or threatening information before that information has entered awareness (*ibid.*). This corresponds with the tendency of anxious individuals to be highly vigilant, and to scan the environment for threatening stimuli. With depression however, Williams suggested that the bias occurs at a later stage of processing which occurs once the information has entered consciousness (*ibid.*). Using a Stroop-type colour naming interference task, Mogg *et al.* found that anxious subjects, in comparison with depressed and normal subjects, showed more colour naming interference when anxiety-relevant and depression relevant words were displayed in both subliminal and supraliminal exposure conditions. This study supported the theory that anxiety is associated with a preattentive bias for negative information. Anxious subjects were therefore sensitive to negative emotional words in the absence of conscious awareness. The study is also consistent with the other evidence showing that semantic processing may occur without awareness.

A later study (Bradley *et al.* 1994) investigated implicit and explicit memory for emotional words in a group of non-clinical subjects. These authors separated their subjects into 2 groups based on measures of state and trait anxiety and a measure of non-clinical depression. They found that the high negative affect group showed greater sensitivity to subliminal priming than the low affect group. No priming effect was obtained with the group exposed to supraliminal stimuli. These authors thus demonstrated that a mood-congruent bias was associated with non-clinical depression.

In a Stroop colour naming task, Bradley *et al.* (1995) found differential interference effects from the subliminal presentation of anxiety- and depression-related words with 3 subject groups: 1. Subjects diagnosed as suffering from Generalised Anxiety Disorder (GAD) without concurrent depression. 2. Subjects diagnosed with GAD with concurrent depression. 3. Normal control group. The following conclusions were reached:

1. Those diagnosed with GAD without concurrent depression showed greater interference effects due to negative words in both subliminal and supraliminal exposure conditions compared with control subjects.
2. In those subjects where anxiety and depression co-existed, the interference bias was no longer present. The authors speculate that depression may inhibit sensitivity to negative information.

Bradley *et al.* concluded that patients suffering from GAD showed a pre-attentive bias, not just for anxiety-related information, but for negative words in general.

2.6.5 UNCONSCIOUS COGNITION: THEORETICAL ASPECTS

A number of theoretical issues come to bear on the question of unconscious cognition. Greenwald *et al.* (1995) provide what is to date, probably the most comprehensive theoretical reflection on unconscious cognition in relation to subliminal research. In this section, a number of important theoretical issues are addressed, and will be discussed in turn. These are as follows:

1) The relationship of conscious to unconscious processes.
2) The nature of direct and indirect experimental effects.
3) The nature of thresholds, (objective vs. subjective).

2.6.5.1. THE RELATIONSHIP BETWEEN CONSCIOUS AND UNCONSCIOUS PROCESSES

Three views are cited by Greenwald *et al.* (1995). They are as follows:

a) *Nonexistence*: unconscious cognition does not exist.

b) *Association*: unconscious cognition exists, but only in association with, or as an adjunct to conscious cognition.

c) *Dissociation:* unconscious cognition exists dissociated from, and independently of conscious cognition (Greenwald *et al.* 1995, p. 22-23).

Proponents of the association view include Cheesman and Merikle (1984) who propose that unconscious effects can be detected when stimuli fall between subjective and objective thresholds (see Cheesman and Merikle, 1984, p. 391). This will be discussed further in section 2.6.4.3. In this situation, as Greenwald *et al.* put it, 'when stimuli produce unconscious effects, they also produce associated but perceptually indistinct conscious effects' (p. 23).

As the term implies, an implication of the dissociation view, as Greenwald *et al.* point out, is that 'there is no potential path for discovery, via conscious perception, that a potential unconscious influence is occurring'. This raises formidable theoretical difficulties regarding detection of unconscious processes.

2.6.5.2. DIRECT AND INDIRECT EFFECTS

As a way of operationalising the difference between conscious and unconscious processes, these are conceptualised respectively as direct and indirect experimental effects. Greenwald *et al.* (1995) consider a direct effect of an experimental stimulus to be that which is the result of a response to an instructed task. This could take the form for example, of a measure of accuracy in the instructed task. An indirect effect is an uninstructed effect of the task stimulus on behaviour. The example these authors give of a direct effect is the Stroop task of naming the colour of the ink with which a word is printed, where a distracting feature would be the spelling of that word with the name of another colour. The indirect effect in this case is that caused by the distracting feature of the word spelling. The practical significance of the difference between direct and indirect effects is that direct effects are thought to reflect the contents of awareness, whereas indirect effects are thought to reflect an unconscious process.

Greenwald *et al.* were concerned to investigate the relationship between conscious and unconscious cognition, hence they took pains to separate direct from indirect effects. They suggest that theoretical conclusions need to come from experiments that obtain both direct and indirect measures of responses to tasks. A basic premise, which seems self-evident, is that unconscious cognition refers to cognition that occurs without awareness (p. 23). This is a fairly informal notion, and receives further clarification by these authors who cite Holender (1986), Reingold and Merikle (1988) and Cheesman and Merikle (1984). Greenwald *et al.* provide a useful summary of these authors' theoretical positions. These will be presented and discussed briefly since they provide valuable points of reference.

Holender takes a sceptical stance concerning the existence of unconscious cognition, and makes strict assumptions about the demonstration of such effects. In order to draw conclusions, Holender assumes that direct measures must be sensitive to **all** conscious effects of the stimuli and must **only** reflect conscious effects (conditions which they term exhaustiveness and exclusiveness respectively). In order for unconscious effects of stimuli to be demonstrated, an indirect effect must occur in the absence of a direct effect. In this manner, dissociation of conscious and unconscious processes will have been demonstrated. Holender therefore rules out *a priori,* the possibility of conscious and unconscious processes being associated.

Holender's strict theoretical position leads predictably to a sceptical stance regarding the empirical literature. Since the studies cited do not, in the view of Holender, give adequate information regarding performance on direct measures, they fail to show indirect effects in the absence of direct effects. Holender's scepticism extends even to those studies which did report the 'indirect-without-direct-effect', and Greenwald *et al.* remark that 'their collective weight appears to have remained insufficient to counterbalance the sceptical position stated in Holender's (1986) review' (Greenwald *et al.,* 1995, p. 23).

Holender's position makes the demonstration of unconscious cognition difficult, given the problem which Reingold and Merikle point out (in Greenwald *et al.* p. 24), of accepting a null hypothesis for the direct effect. Accepting a null hypothesis is one thing, but actually proving it is another. This is problematic from a statistical point of view because of the inherent degree of uncertainty that is involved in making such a judgement. Also, one wonders why direct measures should reflect only conscious contributions to behaviour. Perhaps this is a logical necessity imposed by the distinction made between direct and indirect measures. In reality, these definitions may be too strict.

Reingold and Merikle (1988) suggest a relaxation of Holender's requirement about direct measures. They allow that both direct and indirect measures might show effects of both conscious and unconscious contributions. This relaxation however, makes the inference of unconscious effects difficult, since these may be confounded with conscious effects. Reingold and Merikle suggest therefore that the difference in the effects should be defined statistically. That is, when the effects are defined on a comparable measurement scale, a statistically stronger effect on the indirect measure would suggest the existence of unconscious cognition. This seems to be a useful way of differentiating conscious from unconscious effects since it allows for the possibility of their association, and does not rule it out *a priori*. Differential effect sizes certainly appear to have been established in the subliminal mere exposure studies cited earlier, where there were effects of both conscious and unconscious conditioning. Importantly, one wonders how they are related to each other.

2.6.6 AWARENESS THRESHOLDS, PRIMING EFFECTS AND CONSCIOUSNESS: INTEGRATION OF EMPIRICAL FINDINGS

This section seeks to integrate the research reviewed in this chapter in order to present a more coherent picture of perception, awareness and consciousness. Perceptual thresholds are examined in relation to priming effects, and this relationship is linked in turn to the distinction made between conscious and unconscious processes. Firstly, important work by Cheesman and Merikle (1984) regarding prime detectability and priming effects will be reviewed and the implications for the other research reviewed in this chapter will be discussed. The focus of this discussion is the difference in the **priming effect size** obtained at objective and subjective thresholds. Subjective awareness is suggested as the proper basis for distinguishing conscious and unconscious processes. Secondly, the **type** of processing seen is discussed in relation to consciousness.

2.6.6.1 VALIDATION OF AWARENESS THRESHOLDS

Cheesman and Merikle's (1984) experiment in which they tested for the effects of priming at various levels of prime detectability, showed a positive relationship between prime detectability and the magnitude of priming effects in a Stroop-type task measuring response latencies with congruent and incongruent priming. At this point, these authors challenged Marcel, (1983) and others' findings that 'complete lexical access occurs independently of conscious awareness' by suggesting that the validity of the conclusion depended on the adequacy with which the thresholds for discriminated verbal reports were measured.

In Cheesman and Merikle's (1984) experiment, a number of forced choice trials for prime detection were then run in order to set various detectability thresholds (objectively) in terms of performance. The thresholds were defined at 25% (chance threshold), 55% and 90% detection rates. An additional unmasked exposure condition was used. As prime detectability, (as measured by the objective forced choice trials) increased, so did priming effects.

In a second experiment, Cheesman and Merikle (1984) determined objective and subjective thresholds for each subject before the priming trials. They predicted that the subjective threshold would be at a longer prime-mask SOA than the objective threshold, and consequently that subjects objective detection performance would be at above chance when exposures were made at the subjective threshold. At this stage, these authors set out to show that a subjective rather than an objective threshold was inadvertently used in other masked-prime studies, and they criticised this as an insufficiently rigorous test of unawareness (p. 392). These authors defined the objective threshold in their experiment as 25% correct performance in the forced-choice test (there were 4 choices, hence a chance threshold of 25%), and the subjective threshold was defined as the 'actual observed performance' when subjects **estimated** their initial detection performance as less than 30% correct during a block of 48 threshold detection trials in the forced choice test. The interesting feature of this experiment is that subjects consistently *underestimated* the accuracy with which they were able to discriminate amongst primes in the forced choice test.

The objective and subjective condition threshold means were determined as 30 ms (range: 16.7 - 50 ms) and 56 ms (range: 33.3 - 83.3 ms) respectively. The results of the detection tests showed correct detection means of 27% and 66% for objective and subjective thresholds respectively. Significant priming effects were found with subjects in the subjective threshold condition, and no significant priming effects were found with subjects in the objective threshold condition.

In a later study using the same experimental task, Cheesman and Merikle (1986) replicated the finding that priming effects are seen when a subjective threshold is used (but are not seen when exposures are made at the objective threshold). In addition, they showed that a qualitatively different type of priming occurred between subjective threshold and suprathreshold conditions. In the suprathreshold condition, as the congruent trial **probability** increased, latency **decreased** for congruent priming, and **increased** for incongruent priming. No such effect was evident in the subjective threshold condition where subjects claimed no awareness for the primes. Cheesman and Merikle understood this to mean that in the suprathreshold condition subjects were able to strategise, and hence that response latency changed as a function of subjects' expectancy of congruent primes. As they point out, while a predictive strategy led to improved performance on the congruent trials, it led to a decrement in performance on incongruent trials. They concluded that this finding supported their hypothesis that 'observers can initiate a **strategy** based on the predictive relationship between primes and targets only when they are consciously aware of the primes'. This finding was replicated in the same series of experiments.

Cheesman and Merikle argued on the basis of their (1984) research, that priming effects could be demonstrated when the threshold for discriminative responding was set at the subjective level where subjects were unable, on the basis of self-report, to discriminate masked primes at a greater than chance level.

Cheesman and Merikle began their (1986) research by asserting that the boundary between conscious and unconscious perceptual processing could be defined operationally in terms of subjectively based discriminative responding. Their contention was that no priming effects occurred when thresholds were set at the objective level where subjects were unable to discriminate masked primes at greater than chance levels (on the basis of actual performance).

They infer from this, that subjective awareness is the proper empirical basis for demarcating conscious and unconscious processing. Stimuli perceived with awareness are therefore subject to conscious processes, whereas stimuli perceived without claimed awareness are processed unconsciously. Their research indeed indicates that subjects are only able to strategise when stimuli are perceived in the suprathreshold exposure condition.

2.6.6.2 CONSCIOUS AND UNCONSCIOUS PROCESSING OF INFORMATION

Following this research Cheesman and Merikle reflected that the distinction between conscious and unconscious processes would be further validated if it could be shown that **qualitatively different types of processing occur** between conditions where primes are shown with and without subjective awareness.

There are a number of similarities between the work of Cheesman and Merikle, and that of others. In particular, that of Groeger (1984) and Marcel (1980, in Marcel, 1983) stands out. Groeger's work showed evidence of qualitatively different types of processing between aware and non-aware states: where subjects were unable to consciously perceive primes, semantic analysis occurred, whereas when subjects were able to identify priming stimuli, structural analysis occurred. Marcel showed a difference in subjects' responses between masked and unmasked exposures of a polysemous word. This difference was seen in the qualitatively different type of bias introduced by context words. More context-specific semantic activation was observed in the above threshold condition, whereas a more general, and noncontext-specific semantic activation was seen in the below threshold condition.

In summarising this section, it seems that there are a substantial number of independent and robust findings which imply the following two conclusions:

1) Semantic analysis may occur without awareness: Marcel (1980, in Marcel, 1983); Groeger (1984); Doyle and Leach (1988) (word superiority effect); Bornstein and D'Agostino (1992) (mere exposure effect); Hirschman and Durante (1992); De Houwer *et al.* (1994); (evaluative conditioning in the absence of contingency awareness).

2) Qualitatively different types of processing occur between conscious and unconscious conditions: Groeger (1984), Marcel (1980, in Marcel, 1983) (semantic coding predominating without awareness, structural analysis predominating with awareness); Marcel (1980, in Marcel, 1983) (context specific cues processed only above the threshold of awareness, whereas nonaware processing led to more general semantic activation); Cheesman and Merikle (1986) (awareness needed for activation of an adaptive strategy).

2.6.6.3 SEMANTIC PRIMING REVISITED

The work of Greenwald *et al.*(1995) is impressive because of its extent, the theoretical integration achieved, and the sample size involved in their study (N=2026). These authors used a dioptic method of stimulation with pattern masking on a 80286-type computer with an EGA display. The object of their research was to investigate separate effects of conscious and unconscious cognitive processing. They did this by measuring the effects of both direct and indirect effects of stimulation with a comparable scale, and with a rational zero point for each measure. A linear regression model was used to analyse the relationship between direct and indirect effects based on Reingold and Merikle's (1988) suggestions.

Greenwald *et al.* conducted a series of experiments which determined eye dominance, set detection thresholds, and provided a number of practice trials. After this, a position discrimination task was run in which subjects were scored on a direct measure (based on the hit rate, with a rational zero point corresponding with chance performance), and an indirect measure (the effect of a masked prime stimuli suggesting word position). Another task was also given in which subjects were asked to rate neutral words on a continuum from unpleasant to pleasant. Neutral word presentation was accompanied, on critical trials, with the presentation of a prime word with either a negative or positive meaning (eg. 'killer', 'poison'; 'happy', 'mother'). The direct measure was the judgement of the word, and the indirect measure was the latency time to a correct decision. Either congruent or incongruent semantic priming was possible, and it was expected that incongruent priming would be associated with greater latencies, and congruent priming with shorter latencies. Interestingly, these authors also anticipated that priming effects could take the form of higher error rates with incongruent priming.

The results of the regression analysis showed that above chance performance on the indirect measure was associated with chance performance on the direct measure. This was a highly significant effect (p=0.0016, two-tailed). This corresponded with the 'indirect-without-direct-effect' pattern. However, no significant effects of unconscious influences on evaluative decisions were found in the study. The authors suggest that this data pattern was compatible either with the association of conscious and unconscious cognition model, or with the dissociation of conscious from unconscious cognition model.

Greenwald *et al.* concluded that the 'indirect without direct effect' had been shown statistically, in accordance with the suggestion made by Reingold and Merikle (1988) that dissociation of conscious from unconscious processes could be shown by statistical means, and not simply judged on presence vs. non-presence.

2.6.7 DISCUSSION

In this section, a sample of non-psychoanalytically orientated literature on perception without awareness was presented and discussed. For some time, the subject of priming without awareness has dominated research, and this seems to have been demonstrated quite consistently. The single most important issue emerging from this research is the question of threshold setting. The subjective threshold of awareness is suggested by Cheesman and Merikle as an appropriate practical manner in which conscious and unconscious processes may be separated, and it appears possible that many authors who report findings have used this threshold without making it explicit, or referring to it exactly as such, eg. Groeger, (1984), Marcel (1980, in Marcel, 1983), Hirshman and Durante (1992), Doyle and Leach (1988).

Findings may be summarised thus:

1. Semantic priming without subjective awareness has been demonstrated in a fairly consistent manner.
2. Different types of perceptual processing seem to occur between the conscious and unconscious condition: semantic processing predominates in the unconscious condition (Groeger 1984: recognition based on semantic analysis; Doyle and Leach, 1988: word superiority effect (replicated); Hirshman and Durante, 1992: replication of Doyle and Leach's experiment).
3. Preattentive bias may exist for negative, or threatening information whereby subjects experiencing anxiety, or non-clinical depression show a bias in attending to negative stimuli.
4. Bornstein and D'Agostino's finding that attitudes towards stimuli may be enhanced by repeated below threshold exposure implies semantic priming without awareness.
5. Conscious and unconscious processes may be dissociated (Greenwald *et al.* 1995: dissociation demonstrated statistically).
6. Conscious awareness is required for strategising (Marcel, 1980 in Marcel, 1983; Cheesman & Merikle, 1986).

The general theoretical contributions of the non-psychoanalytic research are:

1. The notion that subjective awareness separates conscious from unconscious processes.

2. The contents of awareness may be measured by direct task effects although plausibly, direct measures might also reflect unconscious contents to some extent.

3. Unconscious processes may be inferred from indirect, or uninstructed effects. An indirect effect must be distinguishable from a direct one.

2.7 GENERAL DISCUSSION

In section **2.4**, two paradigms or experimental traditions were highlighted: SPA and non-psychoanalytically orientated research. A major difference between these traditions is that the former is associated with clinical aspects of psychology, and the latter is not clinically orientated.

It is difficult to compare the findings of the SPA paradigm with those of the non-psychoanalytic paradigm, since the experiments are often quite different in nature. However, some general points are offered:

1. It is difficult to compare the thresholds used in SPA research with those used in non-psychoanalytically orientated research. It seems that claims were made in the former paradigm for activation effects when subjects were exposed at stimulus levels corresponding with the objective threshold. That is, tests of unawareness were done in which subjects were not able to distinguish between target and control stimuli. This is not uncommon in the literature (see section 2.5.1.3.3, point 4 on subliminality). In general, this author was impressed with the rigour with which unawareness was established in SPA research.

2. The SPA research simply assumes that semantic activation and analysis occurs without awareness, indeed this would be a necessary condition for any specific, predictable behavioural effect. One of the problems with SPA research is that this aspect has been overlooked, while researchers have pressed ahead with the testing of ambitious, and to some, exotic psychodynamic hypotheses. The failure of SPA researchers to pay attention to the more basic

issues implied by perception without awareness gives SPA research the appearance and perhaps the reputation of being more like magic than science. This might account for the reluctance of non-psychoanalytically inclined researchers to mention SPA experiments.

3. Having made the above criticisms, it must be acknowledged, however that some SPA effects appear to be robust, and replicable, eg. the oedipal and adaption-enhancing studies 'Mother and I are one'. SPA effects seem to be quite specific in terms of the stimulus shown to subjects, and stimuli concerning the maternal figure appear particularly potent in evoking changes.

4. In general, it seems implausible that the entire body of SPA findings is due to experimental artifacts of one kind or another. The sheer weight of experimental evidence, especially the meta-analyses make it difficult to reject SPA as fraudulent. There are indeed failures to replicate, and enormous difficulties in establishing the validity of psychoanalytic interpretations of SPA effects, but on close examination these do not seem to be as damning as at first glance.

5. Some common ground between the two paradigms may exist with regard to the qualitatively different effects seen between above and below threshold conditions. The fact that subjects are only able to strategise on the basis of conscious awareness seems clear from Marcel's (1983) research, and that of Cheesman and Merikle (1986). A finding which is of central importance to SPA research, is that significant behavioural effects only occur when the stimuli are perceived without awareness (see Bornstein, 1990, 1992). Awareness therefore appears to inhibit effects in SPA.

It seems likely that the type of processing which occurs in the suprathreshold condition (in other words, with subjective awareness) is more sophisticated than that which occurs without awareness (subliminal). Processing without awareness could be characterised as more automatic and certainly cannot be described as intentional in the way that intentionality is usually defined. So, even though semantic activation occurs, no higher, or more integrative types of cognitive processing occurs.

The finding that subjects were able to strategise in the suprathreshold condition, but not in the below-threshold condition may be related to the claim by SPA theorists that subliminal (below threshold) exposures bypass conscious defences, while supraliminal (above threshold) exposures activate these defences. Talbot *et al.* suggest that increased food consumption noted in the subliminal condition reflected an 'action-oriented defence against anxiety and an act of self-nurturance' (1991, p. 821). Increased eating is an indirect effect, and according to this explanation, is therefore the result of a defence which operates without awareness, as opposed to a conscious defence.

It seems that when subjects are shown stimuli supraliminally, conscious defences are activated which counter the effect of the stimuli. Conscious awareness of the threat is therefore needed in order for an appropriate defensive action to be taken. What is termed a 'defence' in the SPA literature, may be comparable to a strategy in the non-psychoanalytic literature. In other words, in the terminology of the latter paradigm, conscious awareness of a threat may result in subjects actively strategising in order to counter it. Feasibly, in some situations subjects may **suppress** certain behaviours in response to a perceived threat, whereas in other situations, various behavioural responses may be **activated**. Both these situations would reflect active, goal-directed and presumably adaptive strategising in the face of a threatening situation. The type of strategy adopted would depend on the options available in the situation, and the various constraints on behaviour. This might be an explanation of the difficulties found in replicating SPA experiments, since some of the nuances of the original experiments may not have been reproduced in the attempted replication.

6. Both SPA and non-psychoanalytically orientated research suggests that conscious and unconscious processes may be somewhat different in nature, and dissociated in function. In psychoanalysis, independence of conscious and unconscious cognition is central and SPA research appears to confirm this. An important finding by Greenwald *et al.* (1995) also offers some support for this hypothesis.

2.8 CONCLUSION

Findings cited in the non-psychoanalytical literature surveyed are not necessarily at odds with those of SPA, but comparison is difficult. Both paradigms offer support for the conclusion that perception and cognition without awareness exists. Different types of processing are thought to occur between aware and non-aware conditions, and subjective awareness is established as the crucial aspect in this regard. Perhaps the question asked by Greenwald *et al.* 'whether unconscious processes are "smart" or dumb"' (in Merikle 1992, p. 794) is the right one. Merikle implies that the question of whether unconscious processes exist has virtually become redundant in the light of the collective weight of recent evidence, and suggests that further research into qualitative differences may reveal 'the ultimate value of the long-standing distinction between conscious and unconscious processes' (*ibid.*).

3. PILOT STUDY

3.1 INTRODUCTION

This chapter describes the development and testing of a subliminal stimulation procedure using a personal computer and *VGA* colour monitor. Two types of subliminal exposure procedures were developed and tested and are described in this chapter:

1) masking by light

2) masking by random noise (Breitmeyer, 1984).

The masking by random noise procedure was found to be the most efficient method of masking.

Computers have been used more commonly for subliminal presentation of stimuli in recent years (eg. Greenwald, *et al.* 1995, De Houwer, *et al.* 1994), apparently with positive results. Before the advent of the microcomputer, the instrument most commonly used for this purpose was the tachistoscope. In some ways, this is the ideal instrument since there is a wealth of research done using the exposure time of 4 ms (see Bornstein, 1992, p. 69). The microcomputer offers certain advantages however, since administration is easier and more flexible. Complex routines can easily be programmed to run on a fairly standard modern *IBM*-type computer with a *VGA* screen, and the data may be captured and scored with relative ease. However, authors who have used personal computers in this way have not published much detail, and for this author, the technique had to be developed from first principles. No information was available on the characteristics of the *VGA* screen for example, and authors do not make their masking algorithms available. A good deal of experimental work had to be done before the technique was reliable enough to be used with a large group of subjects.

3.2 PROPERTIES OF THE *VGA* SCREEN

The algorithm for the subliminal stimulation procedure was developed on an *IBM* type computer with an *80486* processor running at 65 MHz using the *DOS 6.1* operating system. The monitor was a *Tatung Ultra VGA* type with a *Phoenix VGA* adapter card. The monitor was operated in a non-interlaced video mode (i.e. mode 3: 80 columns by 25 rows). The total frame time in this mode is specified by the manufacturer as 16.68 milliseconds with a scanning frequency of 60 Hz.

Test were performed on the screen in order to estimate the actual exposure times obtainable, and to determine what was **actually** being displayed on the screen when a stimulus was presented. Measurement of light at the screen surface was done with a light meter coupled through an amplifier to an analogue to digital converter, sampling at 10 kHz. The typical rise time (the time taken for the screen to reach its brightest level) of the screen was in the region of 1.5 ms, and the amount of decay between one scan and the next was in the order of 55% (i.e. there was a reduction in brightness of 55% to 45% of its highest level). This took place over a period of 13.2 ms. Measurement was done on the surface of the screen with the exposure of a 3-line block of maximum brightness. The amount of time taken for the brightness to decay to 25% of its highest peak was approximately 65 ms. This information is illustrated in Figure 3.1.

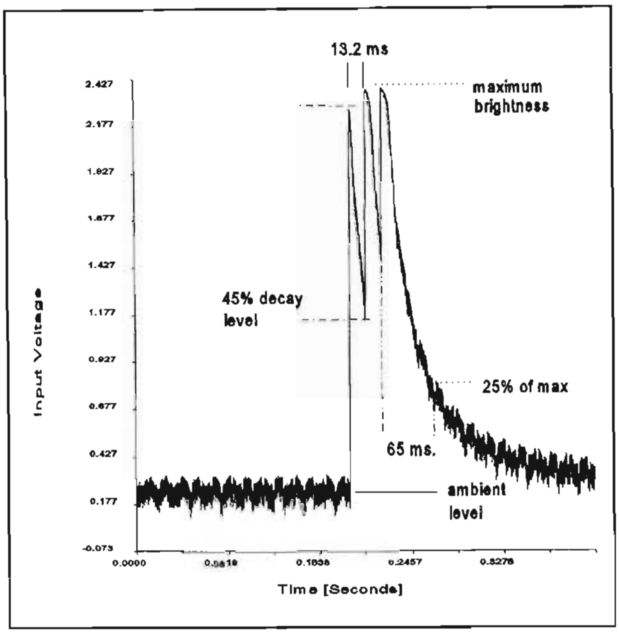

Figure 3.1 Screen scanning characteristics.

In the preliminary stage, light levels at the screen surface were measured with a test phrase that was to be used in the pilot study. It may be seen from Figure 3.2 that the total time from the beginning of the steep rise in brightness until the light value returns to its baseline level is approximately 9.5 ms (unfortunately, considerable 70 Hz noise in the background made more accurate measurement impossible). It was thus estimated that the shortest exposure duration possible using the equipment in this configuration is equal to, or less than 9.5 ms. It is important to note that the initial decay rate of the screen was high, and since the

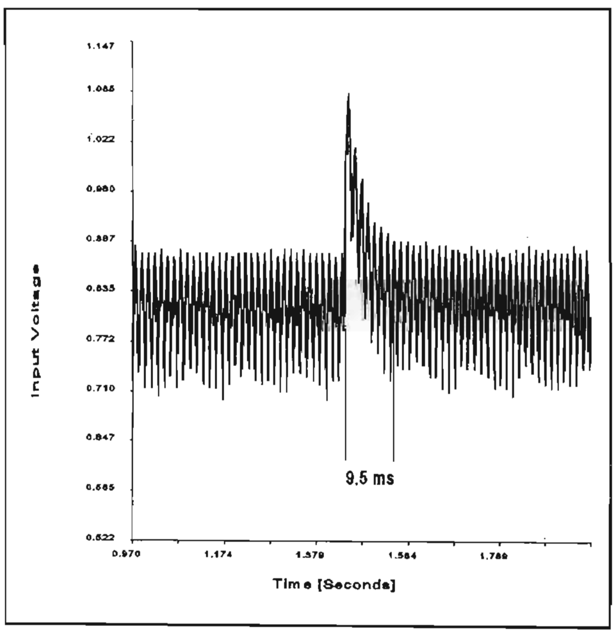

Figure 3.2 Light measurement at the screen surface using a test phrase.

response of the retina to light is logarithmic, the brightness level may drop below the minimum sensitivity threshold before its return to the baseline level. Therefore, although the minimum exposure duration is estimated at 9.5 ms, the effective exposure time may be somewhat less. Unfortunately, a more detailed analysis was not possible because of time constraints and equipment limitations.

An element of randomness was observed in the number of exposures actually displayed on the screen when the programmed exposure time approached its absolute minimum. It appeared that the screen was unable to respond to all program instructions because of the limit imposed either by its scanning speed, or the speed of the video display card. Either way, it appeared that the VDU display could not keep up with the instructions from the CPU, when the exposure time reached its lower limit. An average of eight exposures were actually seen on the screen when 10 such exposures were programmed although no fewer than seven were displayed.

3.3 LIMITATIONS OF THE *VGA* MONITOR

It quickly became apparent, given the relatively slow scanning speed and brightness decay time of the *VGA* monitor, that below threshold exposure times could not be achieved at the shortest exposure duration possible. It was not difficult to read a phrase exposed on the screen at the shortest possible duration. It appears in the literature that unmasked tachistoscopic exposure times are typically in the region of 4 ms, and this is less than 50% of the exposure time possible on this equipment. (Bornstein 1990). Since verbal stimuli could still be perceived at the shortest possible exposure time on the *VGA* screen, other methods were investigated to try to achieve subliminality. One such technique, 'masking by light' (Breitmeyer, 1984) was designed and tested.

3.4 DESIGN AND TESTING OF A MASKING BY LIGHT TECHNIQUE

After some initial experimentation, the masking by light technique seemed promising. A computer program was written in *Pascal* that would briefly expose a phrase in the centre of the *VGA* screen, clear it, then display a bright, uniform mask over the area where the stimulus phrase had appeared (see Appendix A). Success with this method led to the design of an experiment in which 10 phrases were displayed to subjects at decreasing exposure times. The purpose of this experiment was to establish the point at which subjects were no longer able to

Table 3.1 Phrases and exposure durations.

Trial	Exposure (ms)	Phrase
1	43	father is a tease
2	38.7	never rains but pours
3	34.3	lovely day in paradise
4	30.1	all the kings horses
5	25.8	how do people live
6	21.5	shopping can be fun
7	17.2	it is sunny today
8	12.9	have a happy day
9	9.5	April, come she will
10	<9.5	all through the night

perceive a stimulus phrase, or recognise it at a level above chance. This corresponds with the objective threshold defined by Cheesman and Merikle (1984). The sequence, phrases and relevant exposure times used are shown in Table 3.1. The exposure of stimulus phrase 10 was programmed to be shorter than the theoretically minimum possible time of approximately 9.5 ms, and was timed in the program to be displayed for a theoretical 4.3 ms. While this did reduce the potential number of exposures of the target phrase on the screen, it nevertheless guaranteed the shortest exposure time possible on a *VGA* screen.

The conversion factor between the delay units used in *Pascal* and the actual time was calculated by a series of trials in which the screen exposure time was measured by a light meter at the screen surface and recorded by an analogue to digital converter. The digitised data could then be plotted on a screen (with time on the x-axis and amplitude on the y-axis) and precise measurements made. An average factor of 0.216 (SD=0.002) was calculated from the average conversion factors of eight trials ranging from 108 ms to 9.5 ms.

3.5.1 METHOD

Five subjects participated in this study. They were each seated individually in front of the computer and told that they would be exposed to 10 phrases 10 times each, i.e. Phrase 1 would be exposed 10 times at a set exposure time, then phrase 2 at a shorter exposure time until 10 phrases had been exposed at progressively shorter duration times. Subjects were told that the experiment was designed to test visual detection thresholds, and they were instructed to pay close attention to the stimulus phrase in each trial, and try as best as they could to see it. The program displayed these and other relevant instructions at appropriate points. The experimental procedure appears below.

3.5.1.1 DEMONSTRATION

Each subject was given a demonstration of the exposure sequence. In this phase the following were displayed:

a) A focussing dot '☺' was displayed in the middle of the exposure field (3 seconds).

b) A target phrase was flashed in the exposure field at a predetermined exposure time.

c) the mask was displayed (2 seconds) (see Section 2.2 for an explanation of masking).

The timing of this demonstration was exactly the same as that of the experiment proper except that the test phrase was flashed for a relatively long period (0.5 second) to make it more visible. The focussing dot, target phrase and mask were exposed in grey against a dark (unilluminated) background for both the demonstration and experiment proper.

3.5.1.2. TRIALS 1 TO 10

Ten trials were conducted, each consisting of 10 exposures of a) b) c).

For each trial, a target phrase was exposed 10 times to the subject. After 10 exposures of the target, a free recall and recognition trial was performed:

a) FREE RECALL. After each phase, the subject was instructed 'If you were able to see the phrase, type "y"'. If the response was "y" the subject was asked to type out the phrase. If the response was not "y", the subject was asked to guess what the phrase was and to type it out. Subjects were encouraged to type anything that came to mind, even if it didn't make sense.

b) RECOGNITION TRIAL. In this trial, the stimulus phrase was presented in random order with four other phrases, and the subject was asked to identify it. Phrases in this list usually had the same number of words, or were of a similar length, and were designed to resemble each other configurally as closely as possible. The phrases were constructed in such a way that they were all more or less grammatical, but not particularly meaningful. One phrase in each group was matched as closely to the target phrase as possible so that subjects would have to discriminate carefully between them. For example, the word list in trial 10 was as follows:

1. all through the night
2. also throw the knife
3. alter calls help me
4. addle the eggs over
5. under the tall ships

Note the similarity of phrases 1 and 2. The target phrase in this case was 1. All subjects' responses were recorded and written to a file on the hard drive for later analysis.

3.5.1.3 DEBRIEF

All subjects were debriefed and given feedback about their performance. Results were discussed, and comments about the experiment were invited.

3.5.2 RESULTS

Results of the experiment are shown in Figure 3.3 and 3.4. Figure 3.3 displays the average percentage of words correctly recalled in the free recall trial, whether the subject guessed the words or not. This was calculated by scoring the number of correctly recalled words as a percentage of the possible number of words. Credit was given irrespective of word order. Note the following:

a) An apparent learning effect between trials 1 (43 ms) and 2 (38.7 ms) where a rapid improvement was generally observed from 20% to 50% correctly recalled words despite the decreased exposure time.

b) The plateau between trials 2 and 3 (34.4 ms).

c) The gradual decline in correctly recalled words until trial 6 (21.5 ms).

d) The improvement in trial 7 (17.2 ms).

e) Decline until in trial 10 (<9.5 ms) no words were recalled correctly by any of the subjects.

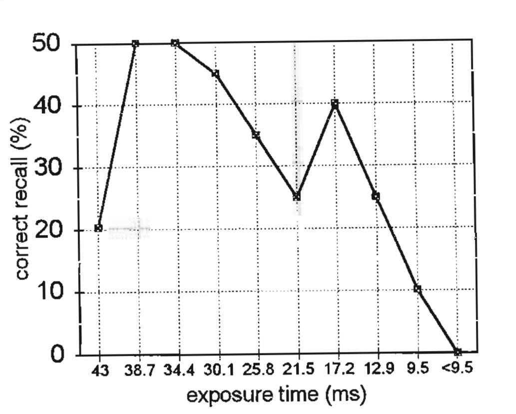

Figure 3.3 Backward masking by light: mean correct word free recall (n=5).

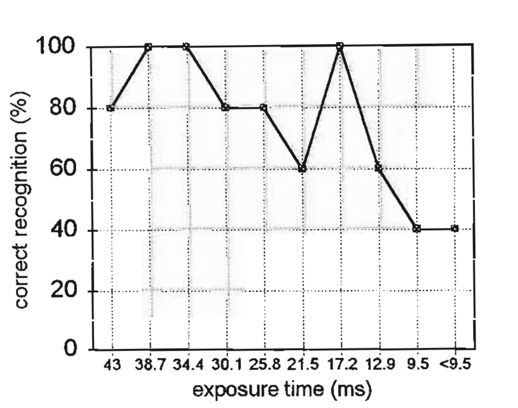

Figure 3.4 Backward masking by light: mean correct phrase recognition (n=5).

Figure 3.4 shows the average percentage of stimulus phrases correctly identified by subjects across trials. The data shows a similar pattern of trends to that of the free recall trials. The following aspects were observed again in the recognition trial:

a) The learning effect which occurred from trial 1 (43 ms) to 2 (38.7 ms).

b) The plateau of 100% correct recognition; (c) subsequent decline across trials 4 (30.1 ms) to 6 (17.2 ms).

d) The peak of 100% on trial 7 (17.2 ms).

e) The decline to 40% on trials 9 (9.5 ms) and 10 (<9.5 ms).

3.5.3 DISCUSSION

The trends seen in the data were in the expected direction, and it seemed clear that the reduction in the number of words recalled and phrases recognised was a function of the decrease in exposure time. In trial 9, an average of 10% of the words recalled were correct (Figure 3.3) and 40% of subjects managed to correctly identify target phrases. No words were recalled correctly in trial 10 by any of the subjects. None were able to suggest any words at all, and responded with comments such as 'haven't a clue' or 'no idea' although one subject reported seeing the phrase. This subject reported seeing the phrase but was unable to recognise it correctly. The reduced recognition and recall scores may have been due to either a slightly reduced exposure time, or simply the fact that fewer exposures were made on the screen due to the synchronisation problem mentioned previously, or a combination of both effects. It is of interest however, that although none were able to correctly recall any of the words from the phrase, two subjects correctly identified the phrase. There may have been a priming effect of some kind which increased the recognition level of the phrases to above that of chance alone. One subject remarked spontaneously that she thought the target phrases had a pattern of being more plausible or acceptable in their meaning than non-targets, so another possible explanation is that the target words were unintentionally cued, and one subject at least may have responded to nuances in this regard.

A possibility was entertained that cues had alerted subjects to the difference between target and non-target phrases. This may have been due to the way in which non-target phrases were constructed, since it was the experimenter's intention that they be configurally similar. Although this could not be decided conclusively, the phrase list was modified for the next experiment. The changes will be described in section 3.6.

In general, it was concluded that this method of masking by light might have inherent limitations. Firstly, factors such as ambient light levels in the room might impact on the subjects' dark adjustment, and this in turn could impact on the perceived contrast between target and mask. Secondly, since the masking effect was highly dependent on the contrast between target and mask, initial screen brightness settings would be another factor to take into account. During this pilot study, the screen was set to a standard value at the beginning of each session, but there was a likelihood that it could constitute a nuisance variable - especially with a large group of subjects using multiple screens.

Apart from the limitations mentioned, it was felt that even at the exposure times of less than or equal to 9.5 ms, subjects' word recall level was still too high. It was pointed out earlier that this may have been due to a subtle pattern in the word list, and an astute subject was able to detect it (this subject also correctly identified all 10 stimulus phrases). However, this subject was not able to identify any of the words correctly in recall trial 9, while another subject was able to guess 50% of the words correctly in trial 9. This leads to the conclusion that it was not the pattern alone which could explain the high level of recall at the exposure time of 9.5 ms. This method of masking by light was therefore not considered reliable enough for the purposes of subliminal presentation of verbal stimuli since exposures were close to the perceptual threshold.

3.6 DESIGN AND TESTING OF A MASKING BY VISUAL NOISE PROCEDURE

Since (admittedly limited) testing had shown the masking by light procedure to be problematic as a method of presenting stimuli below the threshold of perception, another method of *masking by random visual noise* was developed and tested.

Breitmeyer lists the procedure of 'masking by noise' as a type of masking by pattern. Where theories of the masking by light effect explain it in terms of an integration of the stimulus with the mask, masking by pattern theories refer to an interruption of the processing of the stimulus. Two types of masking by pattern procedures exist: ones in which the mask precedes the target are known as *paracontrast* or forward masking types, whereas those in which the target precedes the mask are known as *metacontrast* or backward masking types. Breitmeyer attributes the masking by noise procedure to Kinsbourne & Warrington (1962) who appear to have coined the term (in Breitmeyer, 1984, p. 101). In this experiment, the metacontrast or backward masking technique was used (See Appendix B for *Pascal* source code)..

In the masking by noise procedure the contrast elements and contours of the mask are designed to have no relationship to those of the target. Breitmeyer describes such a mask as a 'random dot mask (1984, p. 101). In research by Marcel (1976, cited by Dixon, 1981, p. 75) the mask is described as 'a jumble of letters or cut-up letters of the same typeface'.

Figure 3.5 Visual noise mask.

The design of such a mask was constrained by the variety of *ASCII* characters available. The graphics characters from 176 to 245 (using the *IBM* character set) were selected because of their neutrality (non-alphabetical). An algorithm was designed to select a random sequence of these characters for each exposure, and the mask was unique every time it was displayed. It consisted of a one-line display of an array of random characters covering the area where the stimulus field had been displayed (centre of the screen). In the program, the mask array was computed before exposure of the stimulus, then displayed after the stimulus field was cleared. Figure 3.5 shows an example of the masking field at approximately the size at which it appears on the screen.

As indicated previously in section 3.5.3, both the target and phrase list were redesigned to avoid the possibility that the meaning of targets phrases were more plausible or presentable. The amended list of target phrases appears in Table 3.2. The recognition phrase list for trial 10 was as follows:

1. all through the night
2. also throw the knife (target)
3. altar calls help me
4. turn the eggs over
5. under the tall ships

Table 3.2 Phrases and exposure durations.

Trial	Exposure (ms)	Phrase
1	81.7	old men prefer coffee
2	73.1	never rains but pours
3	64.5	freedom is hunting
4	55.9	at thee kins hounded
5	47.3	do hot people love
6	38.7	showing men who run
7	30.1	it is sunny today
8	21.5	get the dog to pray
9	12.9	acorns can she wilt
10	<9.5	also throw the knife

Note also that the exposure times were amended so that a wider range of times was tested. Again, the exposure listed as <9.5 ms was timed in the program to be displayed for 4.3 ms in the program.

3.6.1 METHOD

The procedure was identical in all respects to that of the masking by light experiment, and 6 subjects participated in the experiment. The information from sections 3.5.1 to 3.5.1.3 is applicable and will not be repeated.

3.6.2 RESULTS

Results will be given in quantitative terms, and then observations of a qualitative nature will be made.

3.6.2.1 QUANTITATIVE ANALYSIS

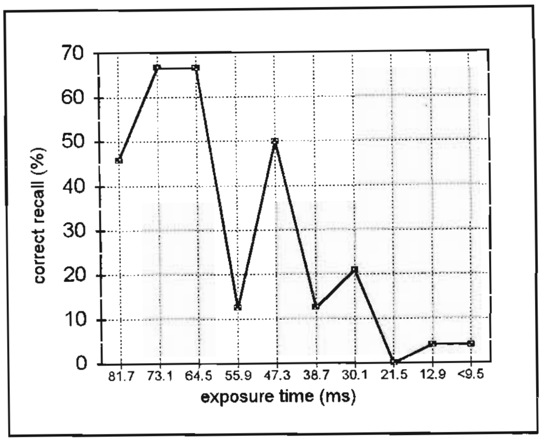

Figure 3.6 Backward masking by visual noise: mean correct word free recall (n=6).

Results are displayed in Figure 3.6 and 3.7. As in the previous experiment, free recall and phrase recognition were tested. As Figure 3.6 shows, the maximum percentage of correctly recalled words was 66.7%. Once more, there appeared to be a learning effect between trials 1 (81.7 ms) and 2 (73.1 ms). Probably because of the increased exposure time, there was a plateau at the much higher level of 66.7% for trials 2 (73.1 ms) and 3 (64.5 ms) - higher than the plateau of 50% observed in the masking by light experiment for trials 2 (38.7 ms) and 3 (34.4 ms). In trial 4 (55.9 ms) there was a sharp drop in the number of phrases recognised, followed by a sharp increase in trial 5 (47.3 ms). After this there was a decrease to the level of 4.2% (SD=9.3) in both trials 9 (12.9 ms) and 10 (<9.5 ms) which were the lowest rates of recall. In trial 9 one subject recalled the word 'she' from the target phrase, but did not recognise it when presented. In trial 10 one subject recalled the word 'the', but also did not recognise the phrase. For comparable exposure times, the average recall rate was much lower using this method of masking. For example in trial 2 (38.7 ms) in the previous experiment an average recall rate of 50% (SD=35.6) was scored, whereas in this experiment, the average recall rate was 12.5% (SD=19.1). For trial 8 (12.9 ms) in the previous experiment, the average recall rate was 25% (SD=27.4) compared with 4.2% (SD=9.3) for the same exposure time in this experiment. It was of interest that the variability in word recall decreased steadily after the learning effect from trial 1 to 2. In trial 2 the standard deviation was 40, and this declined in a predictable manner (apart from trial 4: SD=12.5) until its lowest level of 9.3 in trials 9 and 10. This signifies that with a progression to the minimum threshold, word recall ability and hence perceptual ability between subjects became more uniform.

In Figure 3.7 it may be seen that a 100% recognition rate was scored only on trial 3 (64.5 ms), whereas in the previous experiment there were 3 trials in which 100% was scored. The pattern of the data suggests a variable, but generally high rate of recall for trials 1 to 7 3 (83%), and then a sudden drop to 17% in trial 8. No subjects were able to recognise any of the phrases in trials 9 (12.9 ms) and 10 (<9.5 ms). In the previous experiment there was a recognition rate of 60% for an exposure time of 12.9 ms, and the lowest rate of recognition was 40%. In this experiment, subjects scored 17% for a trial of the same duration, and 0% for both subsequent trials. Measures of variability were generally also lower in the latter experiment.

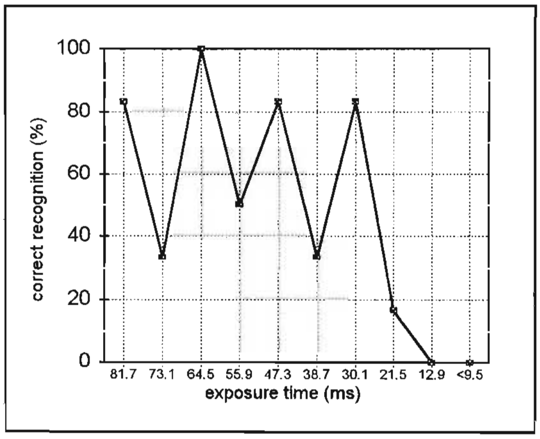

Figure 3.7 Backward masking by visual noise: mean correct phrase recognition (n=6).

In Figure 3.8 a comparison is made between masking by light and masking by noise procedures for trials of equivalent times. The masking by light graph is in the background, and the masking by visual noise graph is in the foreground. Note that the recognition rates in the masking by noise experiment are consistently lower.

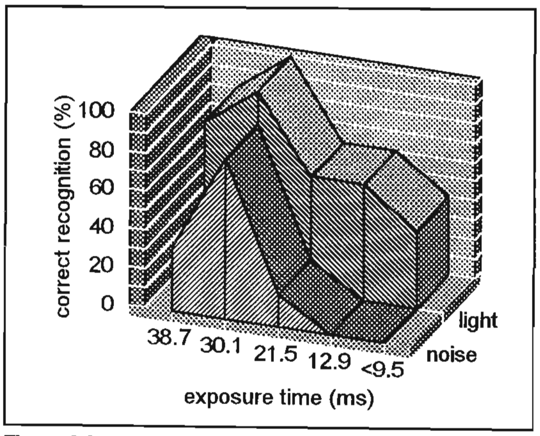

Figure 3.8 Comparison of masking by light and masking by noise: mean recognition rates for equivalent times.

3.6.2.2 QUALITATIVE OBSERVATIONS

Subjects were encouraged to free-associate during the free recall trial, and in trials where phrases were not correctly recognised, interesting qualitative observations were made which suggested a relationship between the target phrase and the subject's free association responses.

Table 3.3 Qualitative observations suggesting a link between target phrases and responses.

Target phrase	Free recall response
ge t the dog to pray	dry
	a peaceful time
	it is written
acorns can she wilt	don't play
	a shelter from the rain
also throw the knife	follow the happy
	help
	a fair deal
	it is hard

Table 3.3 show some responses that were of interest. It may be seen from the table that none of the subjects recalled any of the words from the target phrases in the free recall trial. It was speculated that the responses were a commentary on the target phrases - made without any apparent conscious awareness of their content. For example, the response 'dry' seemed to be a comment on the humorous aspects of the phrase 'get the dog to pray'. The response 'a peaceful time' is quite congruent with the phrase, whereas the response 'it is written' suggests that this subject's sense of spiritual propriety was aroused. The response is reminiscent of a biblical injunction. The second target phrase evoked both a negative and positive response: the negative response 'don't play' had the qualities of a warning, and the positive response alluded to shelter - perhaps a response to acorns (referring to an oak tree?), and rain (a response to the word 'wilt'?). The target 'also throw the knife' evoked emotionally valanced responses of enthusiastic participation ('follow the happy'), fear ('help'), value judgement ('a fair deal') and a sense of adversity ('it is hard'). While the responses were necessarily fragmentary and the suggested connections between the stimulus phrases and responses entail speculation, it was thought that they were potentially a source of projective hypotheses. Generally, it was thought that further investigation of possible connections between the stimulus phrases and responses was warranted.

3.6.3 DISCUSSION AND CONCLUSION

It seemed clear once more, that the trends seen in the data were in the expected direction, and that they reflected subjects' increasing difficulty in recalling and discriminating target phrases from non-targets as the exposure time decreased in duration. Only one subject recalled the word 'she' in trial 9 (12.5 ms), but was unable to correctly identify the phrase. The phrase this subject recalled ('prefer she did') may be said to have had a slight resemblance to the target phrase ('acorns can she wilt') but clearly, recognition of the important elements of the phrase did not occur. Similarly, one subject recalled the word 'the' in trial 10 (<9.5 ms), and was also unable to correctly identify the phrase.

Despite reservations about words occasionally being recalled correctly, the data suggested that the masking by visual noise effect was more predictable, and more effective than that obtained using the masking by light technique. This is seen from the fact that no subjects were able to recognise the phrases in trials 9 and 10 and appeared to be a considerable improvement on the 40% recognition rate obtained using the masking by light technique. A possible confounding variable seen in the previous experiment whereby subtle cues may have existed in the target phrases, was no longer present. This is seen in the fact that no subjects were able to recognise the target phrases in trials 9 and 10.

It was speculated that a subliminal priming effect was beginning to emerge. And the apparent relationship between target and free recall phrases was taken to be evidence for this. This is admittedly tentative and requires further investigation, but it was thought to have some bearing on the remark made by Cattell (section 2.2) regarding the dreamlike quality of the impressions left by subliminal stimulus material. The link between the meanings of stimulus and free recall phrases while oblique and idiosyncratic, may be evidence of a primary thought process, or set of unconscious associations for subjects.

The general conclusion reached by this experiment was that the masking by visual noise technique designed on a personal computer using a *VGA* screen held promise as a method of subliminal stimulation and warranted further investigation with a larger group of subjects. While the samples used were admittedly small, a large number of trials were used for each subject. In other perceptual experiments however, reliability of results was established in that numbers of trials took precedence over numbers of subjects.

4. MAIN STUDY

4.1 INTRODUCTION

In the previous chapter, two masking techniques were described: masking by light and masking by visual noise. These techniques were tested in 2 experiments with a program run on a microcomputer and *VGA* screen. The most promising results were obtained using the masking by visual noise technique, and it was found that subjects were unable to recognise stimulus phrases at exposure times of less than or equal to 9.5 ms. In this section, an experiment will be described where this technique was used on computers connected to a local area network (LAN) with a group of 107 subjects in order to test whether a priming effect could be obtained by subliminal exposure to test phrases (see Appendix C for source code). In this experiment, subjects were exposed subliminally to either a *sad* or *happy* stimulus, and their responses to a homophone task were recorded to test for the presence of such a priming effect. The aim of the experiment was to see whether subliminal exposure to differently mood-valenced phrases could influence subjects' interpretation of ambiguous words.

4.2 MOOD AND COGNITION

Halberstadt *et al.* (1995) remark that it is 'almost a tautology that people who are feeling "down" tend to see events in a negative light, whereas people who are feeling happy seem more generally optimistic'. Findings in the study of mood and cognition suggest that mood facilitates cognition in that it has a biasing effect on cognitive judgements. Mayer (in Sharkey, 1986) suggests that this mood biasing effect occurs in judgements according to whether the prevailing mood is positive or negative. When mood is positive, judgements tend to be skewed in a positive direction, and vice versa. According to Mayer, mood facilitates cognition: as a determinant of plan construction: 1. by altering judgements of the likelihood of success; 2. in the selection of 'the optimal plan' (by assigning mood-linked valences to possible outcomes); 3. as a way of predicting the future (by biasing an estimation of the outcome of future events on previous event-generated moods).

The finding of a mood dependent memory effect by Bower *et al.* (1978), and proposal by Bower (1981) of an associative network theory of mood and memory is frequently mentioned in the literature. According to Teasdale and Barnard (1993), the original experiment which demonstrated mood dependent retrieval, was that done in 1978 by Bower *et al.* These authors demonstrated an effect of mood dependent retrieval by means of lists learned by a group of subjects in two mood states. Later recall was found to be increased when subjects' mood was the same as that in which the material was learned. These early findings are presently seen as problematic since these authors' subsequent attempts at replication have failed (Eich, 1995). This research has been followed by other experiments, and other researchers have had considerable difficulty in replicating the original findings. A possible explanation was suggested by Blaney (1986 in Eich, 1995) and is also mentioned by Bower (1987) to explain MDM (Mood Dependent Memory) effects by a theory of 'mood-congruent' memory. This theory asserts that 'some material, by virtue of its affectively valenced content, is more likely to be stored and/or recalled when one is in a particular mood; concordance between mood at exposure and mood at recall is not required or relevant' (Blaney, 1986, cited by Eich, 1995).

Debate in the literature regarding MDM is extensive, and for the purposes of the present study, a detailed review would be redundant. The issues of cognition and mood, and MDM are mentioned simply as a background for the present research, and possible implications of these issues will be considered in a later chapter.

4.2.1 EMOTION AND THE RESOLUTION OF LEXICAL AMBIGUITY

The Main Study in this thesis was designed around the research of Halberstadt *et al.* (1995) which investigated the role of emotion in the resolution of lexical ambiguity. These authors based their model on that of Bower (1981, 1987), namely the 'emotional network model'. This models states that emotional arousal causes activation of relevant concepts 'as a function of their strength of association to the emotion unit' (p. 278). Consequently, activation is thought to spread to 'the semantic codes for emotion congruent words' (*ibid.*). This signifies that activation of a word meaning is thought to be a 'function of various sources of activation, including priming from within the conceptual network, as well as input from the perceptual system' (*ibid.*).

To test the theory that emotional states guide the resolution of lexical ambiguity, an effect predicted by Bower's emotional network model, Halberstadt *et al.* read out a list of 'affective homophones' to a group of subjects who were exposed to either a *happy* or *sad* mood induction, expecting an emotion-congruent effect. 'Affective homophones' are homophones with both an affective, i.e. either 'sad' or 'happy', and 'neutral' meaning. Their finding was that 'sad' subjects 'wrote significantly more affective meanings of sad words, but the two groups did not differ on the proportion of affective meanings generated for happy words...' (p.81). The authors concluded that this finding replicated and extended previous research on the role of emotion in low-level cognitive processes...' (*ibid)*.

4.2.2 SUBLIMINAL MOOD PRIMING

A number of subliminal semantic priming studies have reported positive results (eg. Marcel, 1983; Groeger, 1984; Hirshman and Durante, 1992). These findings appear to give evidence of unconscious semantic processing where priming is below the subjective threshold, a theory which appears to be increasingly well supported by empirical studies.

There is a relative paucity of research in the area of subliminal mood priming. One study of emotional priming was done by Kemp-Wheeler and Hill (1992). Using a binocular backward masking technique, these authors found that both semantic and emotional priming significantly reduced latency in word production when the primes were related to the target. While these authors had some doubt about the replicability of emotional priming, they concluded, on the basis of combined data from both their experiments, that the effect was robustly significant, and that effects of emotional and semantic priming were equal in magnitude. Interestingly, because of the difficulty in replicating the emotional priming effect, these authors suggest that emotional relatedness may be a weaker form of semantic relatedness, and for this reason, emotional priming effects may not be reliable when primes are presented for an extremely short duration. They therefore suggest that further studies of emotional priming effects over a range of very short prime durations would be interesting (p. 126). A relatively short exposure duration was used in the present thesis (<=9.5 ms) compared with the mean detection threshold time obtained by Kemp-Wheeler and Hill (33.5 ms).

4.3 METHOD

This section will describe the experiment in terms of the subjects, design, subliminal mood priming stimuli and dependent variables. The method, procedure and scoring will be described, followed by a section in which results of both the item analysis and statistical analysis will be described. A Discussion and Conclusion section will briefly discuss and summarise the findings and conclusions.

4.3.1 SUBJECTS AND DESIGN

108 undergraduate students from a psychology class participated in the experiment. The students were required to participate as part of a practical component of their course, and the practical was referred to as a 'study of perception'. One subject was excluded from the analysis because of a 100% error rate in the homophone task. All analysis which follows was based on 107 subjects. The subjects' age was not recorded, but probably lay between 19 and 24 years.

The participants' home language groups were recorded and analysed. Table 4.1 shows the results of an analysis of home language (English/non-English) by gender. Note the relative proportions of men and women: women (n=88) outnumbered men (n=19) in this study. The largest group consisted of English speaking women and in both language groups, women were in the majority.

Table 4.1 Analysis of subject group: English/non-English speaking subjects.

Crosstabulation: Gender By Language

LANGUAGE / GENDER		NON ENGLISH 1.00	ENGLISH 2.00	Row Total
MEN	1	10	9	19 17.8
WOMEN	2	25	63	88 82.2
	Column Total %	35 32.7	72 67.3	107 100.0

Table 4.2 Analysis of subject group: non-English speaking subjects.

Crosstabulation: Gender By Language (NON ENGLISH)

LANGUAGE / GENDER	Count	ZULU	XHOSA	OTHER AFRICAN	OTHER	Row Total
MEN	1	10				10 28.6
WOMEN	2	14	4	4	3	25 71.4
	Column Total%	24 68.6	4 11.4	4 11.4	3 8.6	35 100.0

Table 4.2 shows a further breakdown of the non-English

home language groups into their respective language categories. Note that the majority of non-English speaking subjects were women and had Zulu as their home language. All the non-English speaking men had Zulu as their home language.

The independent variable was the type of subliminal mood manipulation or priming (*sad/happy*) which the subjects received, and the dependent variables consisted of the subjects' responses to a homophone task designed by Halberstadt *et al.* (1995). A comparison was therefore made between groups with the independent variable subliminal *condition*. Other independent variables were *gender* (male/female) and *language* (English/non-English). The classification English/non-English was used since not all non-English speaking subjects were black, and could therefore not be accurately categorised as such. The term 'non-English' simply reflects home language background, and not race or culture *per se*.

An analysis of the various groups was performed to determine their relative compositions since subjects were assigned to a *sad* or *happy* group in a random manner. Table 4.3 shows the results of a *condition* by *gender* analysis. The distribution of men and women across the subliminal *condition* does not deviate significantly from chance (χ^2=0.213, df=1, p=0.64, with Yates correction).

Table 4.3 *Condition* by *gender* analysis.

Crosstabulation: CONDITION By GENDER

GENDER / CONDITION	Count	MEN 1	WOMEN 2	Row Total
SAD	1	11	43	54 50.5
HAPPY	2	8	45	53 49.5
	Column Total	19 17.8	88 82.2	107 100.0

An analysis of *condition* by *language* is displayed in Table 4.4. The groups were closely matched in terms of language (English/non-English) and in terms of the variable *condition*, the difference between the groups was non-significant (χ^2=0.005, p=0.95

Table 4.4 *Condition* by *language* analysis.

Crosstabulation: CONDITION By LANGUAGE (All)

LANGUAGE / CONDITION	Count	NON-ENGLISH 1.00	ENGLISH 2.00	Row Total
SAD	1	17	37	54 50.5
HAPPY	2	18	35	53 49.5
	Column Total	35 32.7	72 67.3	107 100.0

with Yates correction).

The method of determining subliminal *condition* appeared to have been acceptable (see section 4.3.3) since the resulting groups appeared to be uniform in terms of their composition ('sad' group: 50.5%; 'happy' group: 49.5%) and the groups (gender, language) were fairly evenly distributed across the *happy* and *sad* subliminal conditions.

4.3.2 TEST MEDIUM

All data collection and subliminal stimulation was carried out by computer. This was all done with a program written in *Pascal* source code. The *exe*cutable program file was run from a file server on a Local Area Network (LAN), and data from each subject's machine was written to a unique file on the server. The experiment did not entail any written work (pen and paper) on the part of subjects, but required them to type in all relevant information and responses.

The computer program collected information about subjects' gender and home language group and determined the subliminal condition that each subject was assigned to. Instructions and prompts were displayed at each stage, and subjects were prevented from proceeding at certain stages by the use of passwords which had to be keyed in at the demonstrator's instructions.

4.3.3 SUBLIMINAL PRIMING METHOD

In this experiment, mood manipulation was done by means of sub-threshold exposures to phrases. The phrase designed to induce a sad mood was 'GREY AND SAD', and that designed to induce a happy mood was 'BRIGHT AND HAPPY'. The phrases were presented in upper case for the approximate duration of 9.5 ms, and the backward masking by visual noise method was used to mask them. The phrases were programmed to be displayed 15 times.

Before the experiment, each subject was assigned a separate practical (from 1 to 220) and seat number (from 1 to 30). The seat number determined the computer that each participant would be assigned to in the experimental session, and the practical number determined whether the subject was assigned to a *sad* (Group 1) or *happy* (Group 2) group for the subliminal mood condition. Subjects with odd numbers were assigned to Group 1, and those with even numbers were assigned to Group 2. The practical number was also the name assigned to the result file of each subject. For example, if subject's practical number was '30', s/he would be assigned to Group 2 (*happy*), and the name of the result file written to the file server would be '30'.

4.3.4 HOMOPHONE TASK

A task described by Halberstadt *et al.* (1995) was used to test for the effects of the subliminal mood induction. In this task, a list of homophones[12] (Table 4.5) was read out, where each word had a 'sad' or 'neutral' meaning, or a 'happy' or 'neutral' meaning. The list was a combination of both 'sad/neutral' and 'happy/neutral' words. An example of a 'sad/neutral' homophone is 'banned/band', and an example of a 'happy/neutral' homophone is 'bridal/bridle'. A list of 19 words (Table 4.5) compiled by Halberstadt *et al.* (1995) was read out to the subjects, who then typed them on the computer. Subjects were read the list (in which words were placed in random order) by the demonstrator in the experimental session.

Table 4.5 Homophones and their associated emotional valence.

Homophone pair	happy	sad
1 medal-meddle	*	
2 hymn-him	*	
3 die-dye		*
4 sweet-suite	*	
5 won-one	*	
6 mourning-morning		*
7 heal-heel	*	
8 bridal-bridle	*	
9 presents-presence	*	
10 banned-band		*
11 bored-board		*
12 dear-deer	*	
13 poor-pore		*
14 missed-mist		*
15 fined-find		*
16 peace-piece	*	
17 rose-rows	*	
18 pride-pried	*	
19 pain-pane		*

The words were scored according to spelling, and the possibilities and scoring assignments are outlined in the examples below:

Eg.	'Bridal' = 'happy':	score = 1
	'Bridle' = 'neutral':	score = 3
	'Banned' = 'sad':	score = 2
	'Band' = 'neutral':	score = 3
	Other spelling = error:	score = 4.

[12] *The American Heritage Dictionary of the English Language* (1992) defines a homophone as 'One of two or more words, such as *night* and *knight*, that are pronounced the same but differ in meaning, origin, and sometimes spelling.'

The original word list presented two problems: Firstly, the homophone (medal-meddle) was intended to be interpreted as either 'medal' or 'metal' when the American pronunciation was used since the 't' of metal is pronounced as a 'd'. The local pronunciation style prevalent (South African English) made either 'medal' or 'meddle' possible (respectively 'happy' and 'neutral'). This was not ideal since 'meddle' is possibly more negative than 'metal'. Secondly, the American pronunciation of the homophone 'poor' is equivalent to the local pronunciation of the word 'pore', and the local pronunciation of 'poor' does not resemble the word pronounced 'pore'. This difference in pronunciation did not become apparent until the time of the experiment, so it was decided to exclude this homophone from the analysis. Only 18 homophones (11 'happy/neutral' and, 7 'sad/neutral') could therefore be analysed.

It was hypothesized that subjects who were exposed to the *sad* stimulus (*Condition* 1) would spell more homophones from the 'sad/neutral' list as 'sad' words and fewer as 'neutral' words, whereas subjects exposed to the *happy* stimulus (*Condition* 2) would spell fewer 'sad' homophones as 'sad' words and more as 'neutral' words. Subjects in *Condition* 1 were expected to spell more words from the 'happy/neutral' homophone list as 'neutral' words and fewer as 'happy' words. Those in *Condition* 2 were expected to spell more words as 'happy' and fewer as 'neutral'. Table 4.6 summarises the subliminal priming *condition* and the expected direction of the scores of words from both lists.

Table 4.6 *Conditions*, homophone type, and expected direction of scores.

CONDITION	**HOMOPHONE TYPE** 'HAPPY'	'SAD'
1 (*SAD*)	+neutral -happy	+sad -neutral
2 (*HAPPY*)	-neutral +happy	-sad +neutral

Halberstadt *et al.* rated the emotional valence of the homophones by asking a group of subjects (N=41) to rate them as related to both happiness and sadness on a Likert-type scale. The average score of the relatedness to happiness for 'happy' homophones, and sadness for 'sad' homophones (where 1 is the weakest relation and 7 is the strongest relation) was 5.85, and 6.06 respectively. Table 4.5 shows the homophone list in the order in which it was presented in the present study, with the 'happy/sad' word listed first. 'Sad' homophones had to be at least one standard deviation above the mean for all pretest words in their relatedness to sadness according to Halberstadt *et al.*, and likewise 'happy' homophones had to be at least one standard deviation above the mean for all pretest words in their relatedness to happiness.

4.4 PROCEDURE

The subjects were required to sign up for the class practical, and could choose one of eight 30 minute sessions. Each subject was assigned a seat number and practical number. The seat designated one of 30 seats in the computer room, and the practical number was used to identify subjects' data files on the file server.

STAGE 1: INTRODUCTION

When the subjects were seated correctly, the demonstrator introduced himself, thanked the subjects for attending, and informed them that the session was the experimental part of their practical course, and concerned the subject of perceptual thresholds and auditory responses. The demonstrator told the subjects that they would be debriefed at the end of the session, and that a comprehensive explanation of the experiment would be given during a lecture scheduled for the following week. It was emphasised that the session did not involve any tests of ability. Subjects were requested to remain silent at all times, and not to communicate with anyone except the demonstrator.

In the introduction, general instructions were given, and the subjects were asked to proceed only at the instruction of the demonstrator. At each stage in the program, the screens were numbered and subjects were asked to be aware of the screen numbers in the top left hand side of the screen in order that everyone could work together. Instructions were read by the experimenter at each stage.

STAGE 2: EXPERIMENT

The program stages were as follows:

Screen 1: Recorded 'practical' number.

Screen 2: Recorded 'seat' number.

Screen 3: Recorded subjects' gender.

Screen 3b: Recorded subjects' home language.

Screen 4: Demonstration instructions informing subjects of the sequence of the 'Perception' experiment: 1). A focussing dot ('☺') would be displayed in the centre of the screen. 2). A phrase would be flashed in that area (in this case at a relatively long exposure of 2 seconds. 3). A mask of random characters would then be displayed.

Screen 5: The message: 'This is what you will see... Wait a moment!' Demonstration.

Screen 6: Subjects were informed that they would be shown 1 phrase 15 times in the same sequence as the demonstration. They were asked to try as hard as they could to see the phrase.

Screen 7: The subjects were introduced to the next phase of the experiment.

Screen 8: Subjects were asked to type in the phrase that they saw, and if they did not see anything, to type in the first words that came to mind.

Screen 9 -10: Subjects were requested to wait for further instructions, and then the word 'GO' had to be entered in order to proceed. This was done in order that subjects could enter the correct homophone at each stage.

Screens11-29: The homophones were read out in the order that they appear in Table 4.5, and the subjects typed responses on the computer. Each screen was colour coded to ensure synchronisation between subjects.

At the end of the program, subjects were thanked for their participation, and asked not to leave until they had been debriefed.

STAGE 3: DEBRIEF

When all subjects had completed the procedure, they were informed that they had been given 15 subliminal exposures to one of two phrases, depending on whether their seat numbers were odd or even. The meaning of the term 'subliminal' was explained briefly, and the phrases were divulged. The subjects were informed that the aim of the experiment was to see if the subliminal exposure to the phrases could influence the manner in which they interpreted and spelt the homophones.

STAGE 4: RELAXATION EXERCISE

In order to counter possible negative effect which exposure to the *sad* phrase may have caused, participants were given a three minute relaxation exercise.

STAGE 5: TERMINATION

The subjects were thanked for their participation, and asked to contact the demonstrator if anything had bothered them during the experimental session.

4.5 RESULTS

This section will describe the treatment of the data, item analysis and statistical analysis. Findings that are of interest will be presented. At appropriate points, theoretical aspects of the statistical analysis will receive comment, and a number of issues will be raised in this regard.

Table 4.7 List of words corrected.

original	change	original	change
boored	bored	hymne	hymn
prescences	presence	bourd	board
himn	hymn	bord	bored
medle	meddle	hyme	hymn
brydal	bridle	presecence	presence
bridlr	bridle	hym	hymn
ono	one	medel	medal
prsents	presents	pridse	pride
moarning	mouring	brival	bridal
pearce	peace	moning	morning
s weet	sweet	hheal	heal
presense	presence	swet	sweet
payne	pane	brital	bridal
prescence	presence	mornig	morning
heale	heal	im	him

4.5.1 DATA CLEANING

Data from the experiment was written to the file server in *ASCII* files. After the data files had been merged, a spell check was done to correct minor mistakes. A rule was formulated thus: a word was changed if one character could be moved, changed, or deleted and the result of such a change would be a word with the correct spelling corresponding to one of the possible meanings of the homophone. No more than one character was changed in the manner described unless it was quite clear that the word was a misspelling of one of the homophone meanings. A list of the changes is given in Table 4.7. Some of the word changes listed were done more than once, and a total of 45 minor errors were corrected.

One individual's result file was deleted since all the responses in this file were errors and the number of files was reduced from N=108 to N =107. The total number of errors made by all subjects (N=107) was 240, and the mean number of errors made was 2.24 (another way of expressing this information). After the data had been cleaned, the number of errors was reduced to 195 and the mean was 1.8 (SD=2.18). An error score frequency plot is shown in Figure 4.1.

An analysis of variance showed a highly significant difference (p<0.001) between English and non-English home language groups in the number of errors made on all 18 items. The average number of errors made by the English home language group (N=72) was 0.68, whereas that of the non-English speaking group (N =35) was 4.17. It seems self-evident that those whose home language is not English were less familiar with the language, and therefore more prone to making errors.

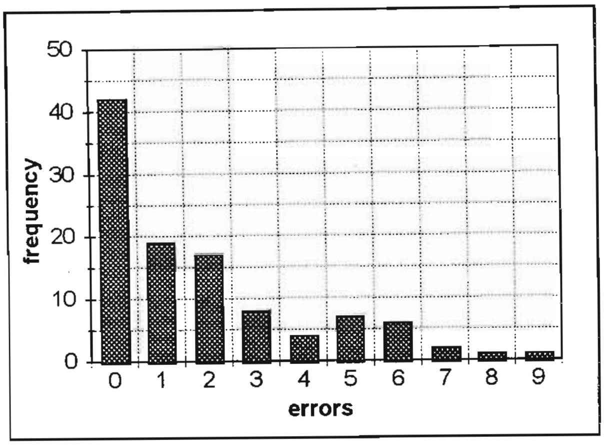

Figure 4.1 Error scores: cleaned data.

4.5.2 SCORING

A program was written in *Pascal* source code to score the data from the experiment (Appendix D). The score coding was given in section 4.3.4 (*happy*=1; *sad*=2; *neutral*=3; *error*=4), and a category score was computed for each word. In addition, score totals were computed for each subject in the following manner:

1) a *happy* total as the sum of all the words scored as 1;

2) a *sad* total as the sum of all the words scored as 2;

3) a *neutral* total as the sum of all the words scored as 3;

4) a *happy/neutral* total as the sum of all the 'neutral' words from the 'happy' list of homophones. In the following list for example, the words in **bold** would be 'happy/neutral' ones: 'sweet/**suite**'; 'won/**one**';

5) a *sad/**neutral*** total as the sum of all the 'neutral' words from the 'sad' list of homophones. Examples of '*sad*/**neutral**' words are: '*die*/**dye**'; '*mourning*/**morning**';

6) an error total (*error-happy*) which was the total number of errors made in the 'happy' list

7) an error total (*error-sad*) which was the total number of errors made in the 'sad' list.

The breakdown of *neutral* scores in this way was done after analysis showed that the respectively *happy/sad neutral* scores did show different patterns of variance. For example, an analysis of variance (one-way) showed a non-significant difference between non-English (Group 1) and English (Group 2) home language subjects on the *happy/neutral* scores (F=0.4, df=1, p=0.53), but a highly significant difference[13] between these groups on the *sad/neutral*

[13] Some statisticians believe that the probability level is important in judging the degree of significance of a statistic (see Howell, 1997, p. 97).

scores (F=28.3, df=1, p<0.001). The *neutral* score reflects this difference (F=15.5, df=1, p<0.001), but the additional breakdown provides potentially valuable information, since the mean score for Group 1 was 0.37, and that of Group 2 was 0.38 for *happy/neutral* scores, whereas for *sad/neutral* scores, the means were 0.38 and 0.53 for the same groups respectively (based on 18 items). It can thus be inferred that English home language subjects were significantly more likely to give 'neutral' spellings of homophones in the 'sad' list than non-English home language subjects.

It was also decided to break down the error scores on the different lists of words since there was a different pattern of errors between the 'happy' and 'sad' homophone lists. The variables were called *happy errors* and *sad errors* respectively.

4.5.3 COMPOSITIONAL SCORING METHOD

The totals for each subject described in the last section (*happy; sad; neutral; happy/neutral; sad/neutral; happy errors; sad error*) are not all independent of each other. For example, if the number of 'happy' words recorded by the subject was known, the number of 'happy/neutral' words would be determined, provided that no errors were made. Likewise, if the number of 'sad' words recorded by the subject was known, the number of 'sad/neutral' words would be determined, provided that no errors were made. Thus, the *happy* and *happy/neutral* variables were dependent on each other, and likewise the *sad* and *sad/neutral* variables, apart from the effects of errors. This dependency would be reflected, for mathematical reasons, in negative correlations between *happy* and *happy/neutral* scores, and between *sad* and *sad/neutral* scores, and the correlation would not be meaningful. On the other hand, *sad* and *happy* variables were independent of each other, although both were influenced by errors.

Aitchison (in Lovie & Lovie, 1991) defines compositional data as 'consisting of vectors whose components represent the proportions of some whole or unit...' (p. 214) and suggests a method whereby the mutual constraints of the components of a given vector can be reflected. For example, the total (t_i) score for all 'happy' homophones (where 'i' represents the components *happy total:* x_1; *happy/neutral total:* x_2; *happy errors:* x_3) could be expressed thus: $t_i = x_i/(x_1 + x_2 + x_3)$ where t_i represents unity. Thus, the unit-sum constraint ($x_1 + x_2 + x_3 = 1$) is taken into account and the components of the vector are essentially ratios ($x_1 : x_2 : x_3$).

With this logic in mind, subjects' total scores were calculated in accordance with the following parameters: the total number of 'happy' homophones used for the analysis was 11, and the total number of 'sad' homophones used was 7, a total of 18 items. The scoring equations for 'happy' and 'sad' homophones respectively, are shown below (in other words, compositional scores are used when there is a dependency in the data between variable, where enlarging one score necessarily reduces another).

$$Total_{happy} = \frac{Happy}{11} + \frac{H_{neutral}}{11} + \frac{H_{errors}}{11} = 1.$$

$$Total_{sad} = \frac{Sad}{7} + \frac{S_{neutral}}{7} + \frac{S_{errors}}{7} = 1.$$

Figure 4.2 shows the composition of two cases for 'happy' and 'sad' homophones: the graph in the upper left hand side of the figure represents the scores (subject 1) for the 'happy' homophones, and that on the upper right hand side represents the scores for the 'sad' homophones. The lower figures represent the same score compositions for another subject (subject 2). The scores are represented as (emotionally) valenced (*happy* or *sad*), 'neutral' (*happy/sad neutral*) and errors (*happy/sad*) and are presented as percentages. Subject 1 spelled 0.50 (50%) of the total number of words in the 'happy' homophone list as 'happy' words, 0.38 (38%) as 'happy/neutral' words, and 0.12 (12%) were errors. Similarly, this subject spelled 0.57 (57%) of the words in the 'sad' homophone list as 'sad' words, 0.29 (29%) of the words as 'sad/neutral' words, and 14 % as errors. Note that subject 2 did not make any errors in either list.

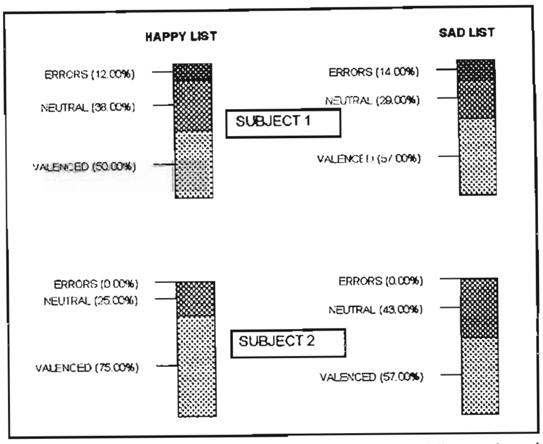

Figure 4.2 Score compositions for 2 cases of 'happy' and 'sad' homophones.

4.5.4 ANALYSIS OF VARIANCE

An initial step in analysing the data was to assess the effects of the independent variables subliminal *condition, gender and language.* A factorial model was generated with these independent variables, and the following 6 dependent variables were analysed: *happy, sad, happy/neutral, sad/neutral, happy errors, sad errors.* The variables *neutral* and *errors* were also analysed, but will not be presented since the variables *sad/neutral*, *happy/neutral, happy errors* and *sad errors* yield more precise information. A full explanation of the dependent variables is given in sections 4.5.2 and 4.5.3. The ANOVA was based on 18 items, and the results will be presented for each dependent variable (See Appendix H).

4.5.4.1 DEPENDENT VARIABLE 1: *HAPPY*

The English group scored significantly higher on this variable than the non-English group (means 0.68 vs. 0.51 respectively; F=27.16, df=1, p<0.0009). There were no interactions between the independent variables.

4.5.4.2 DEPENDENT VARIABLE 2: *SAD*

Only one significant difference was seen in this variable: females' scores were significantly higher than those of males (means 0.43 vs. 0.31; F=6.0, df=1, p<0.016). No significant interactions were found between the independent variables.

4.5.4.3 DEPENDENT VARIABLE 3: *HAPPY/NEUTRAL*

No significant differences were found between any groups on this variable.

4.5.4.4 DEPENDENT VARIABLE 4: *SAD/NEUTRAL*

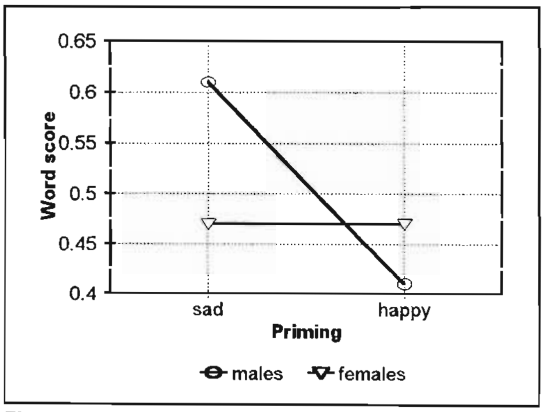

Figure 4.3 Sad/neutral: *condition* by *gender* interaction.

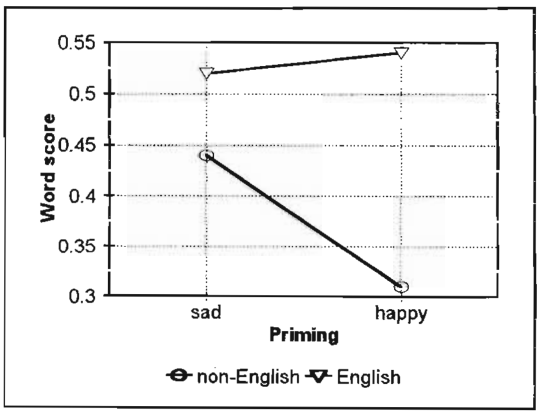

Figure 4.4 Sad/neutral: *condition* by *language* interaction.

There were 2-way interactions between subliminal priming *condition*, *language* and *gender* in this variable, but these were not statistically significant (*condition* by *language*: F=2.86, df=1, p=0.09; *condition* by *gender*: F=2.73, df=1, p=0.1). Note in Figure 4.3 that males tended to have higher *sad/neutral* scores in the *sad* condition while there was no change in the female group associated with subliminal priming. Figure 4.4 shows that non-English subjects tended to have lower scores in the *happy* condition, while English subjects tend to have slightly higher scores in this condition. These interactions should be regarded with caution since they were not statistically significant. There is a suggestion however, that generally males and the non-English group were reactive to subliminal priming.

There were significant main effects of both *condition* and *gender* in this variable, when these independent variables were analysed discretely. Subjects spelled more neutral words in the *sad* subliminal condition than in the *happy* condition (means 0.5 vs. 0.46, $F=5.15$, df=1, $p<0.05$) although this difference is slight. This finding fits with the trends (*condition* by *gender*; *condition* by *language*) noted earlier that subjects tended to spell more 'neutral' words in the *sad* condition (see Figure 4.3 and 4.4). Male subjects spelled more 'neutral' words than females (means 0.53 vs. 0.47, $F=4.34$, df=1, $p=0.05$), also a relatively small difference.

4.5.4.5 DEPENDENT VARIABLE 5: *HAPPY ERRORS*

non-English subjects made far more errors in the 'happy' homophone list than English subjects (means 0.22 vs. 0.04; $F=66.48$, df=1, $p<0.0009$). No effects of the other independent variables were evident. [14]

4.5.4.6 DEPENDENT VARIABLE 6: *SAD ERRORS*

A number of significant interactions were seen in this variable.

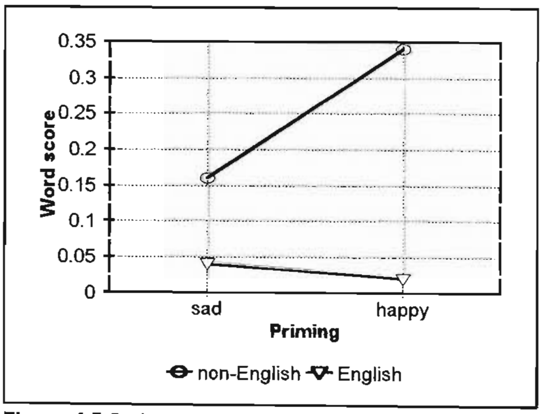

Figure 4.5 Sad errors: *condition* by *language* interaction.

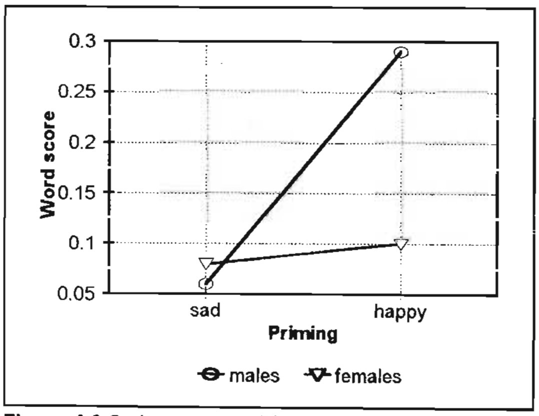

Figure 4.6 Sad errors: *condition* by *gender* interaction.

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[14] These means (*happy errors,* and also *sad errors*) are also based on the compositional scoring method, and reflect the error ratio relative to the other scoring possibilities, and not simply the number of errors made.

There was an interaction between *language* and *condition* (F=14.52, df=1, p<0.0009). The group means are shown in Figure 4.5. There was also an interaction between *gender* and *condition* (F=4.79, df=1, p<0.05). The means are shown in Figure 4.6. Significant main effects of *language* and *condition* were also seen in this variable. non-English subjects made more errors than English subjects (0.25 vs. 0.03, F=78.97, df=1, p<0.0009). Subjects generally made more errors in the *happy* condition (0.08 vs. 0.13, F=18.1, df=1, p<0.0009).

4.5.4.7 SUMMARY OF FINDINGS

The general findings of this analysis are as follows:

1. English subjects spelled more 'happy' words than non-English subjects.

2. Female subjects spelled more 'sad' words than males, who conversely, spelled more 'sad/neutral' words.

3. The following trends were seen: a) Males spelled more 'sad/neutral' words in the *sad* subliminal condition than females. There was virtually no change in females' scores. b) non-English subjects produced fewer 'sad/neutral' words than English subjects in the *happy* subliminal condition.

4. Generally more 'neutral' words were spelled by all subjects in the *sad* subliminal condition; this was a slight, but significant difference.

5. Generally subjects made more errors in the 'sad' word list (variable: *sad errors*) when they were exposed to a *happy* subliminal prime.

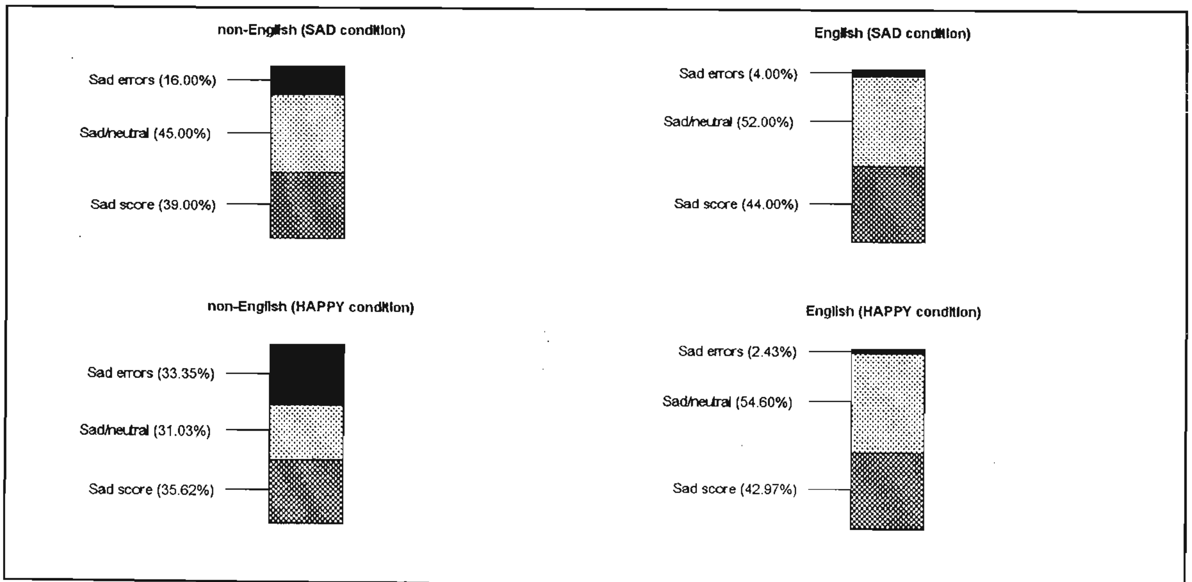

Figure 4.7 Comparison of scores for English and non-English groups across *sad* and *happy* subliminal conditions ('sad' word list).

These findings can be seen in Figure 4.7 and Figure 4.8. In these graphs, the means are expressed as percentages since this reflects the compositional nature of the data, and makes the relationship between the variables clear. In each figure, note the change in score composition between the groups and across the variable subliminal *condition.* In both figures, the groups represented on the left hand side were reactive to *condition.* It is clear that the groups most reactive to subliminal *condition* were the non-English, and male groups.

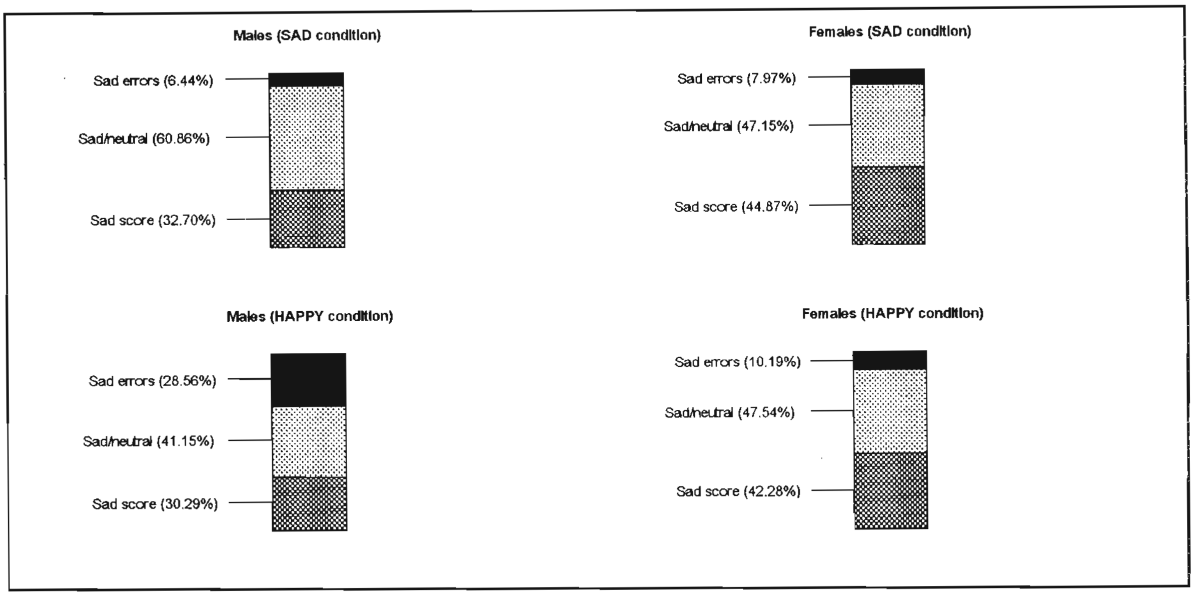

Figure 4.8 Comparison of scores for male and female groups across *sad* and *happy* subliminal conditions ('sad' word list).

A response to the subliminal *condition* only occurred with 'sad' homophones. The response took the form of an increased number of 'neutral' word spellings in the *sad* condition, and an increase in the number of errors made in the *happy* subliminal condition. *Sad* subliminal priming was thus associated with a tendency to spell 'neutral' words, and *happy* subliminal priming was associated with a tendency to make errors. The former response may be seen as a tendency to avoid spelling mood-congruent words in the *sad* condition, while in the *happy* condition it could be seen as a response to incongruent priming (where the emotional valence of homophone was incongruent with that of the prime). This effect was most specific to certain groups of subjects, and to the 'sad' word list. Interestingly, Greenwald *et al.* predicted that priming effects could take the form of higher error rates with incongruent priming (1995, p 31).

4.5.5 ITEM ANALYSIS

Some evidence for a priming effect was discovered in the preceding analysis. The nature of the priming effect appeared to be an (avoidant) tendency to spell 'neutral' words when subjects were exposed to a *sad* subliminal stimulus, and a marked tendency to make errors in the *happy* condition. Effects were also associated with *gender* and home *language* factors.

The complexity of the subliminal priming effect, and the interactions between the priming effect and other independent variables suggested that a more detailed investigation was needed. A detailed item analysis was therefore seen to be necessary to understand the data. This analysis was done in 4 stages. Each stage will be described under a separate sub-heading.

1. The initial frequency with which words were selected will be considered as a gross measure.
2. A factor analysis was performed using all 18 items in order to summarise the data and investigate patterns of variance.
3. A chi-square analysis of the effect of the independent variables *condition, home language* and *gender* will be considered.
4. The results of a study in which items were rated by another group of subjects will be presented and discussed.

4.5.5.1 WORD SELECTION FREQUENCY

The items were examined in terms of the relative frequency with which each word was recorded. For each homophone, two word spellings were possible depending on the valence of the homophone: for 'happy' homophones, a 'happy' and a 'neutral' spelling was possible (eg. 'won' and 'one'). For 'sad' homophones a 'sad' and 'neutral' spelling was possible (eg. 'die' or 'dye'). Words that did not conform to the correct spelling were coded as errors. A good homophone for this task would tend to produce an equal amount of emotionally valenced and 'neutral' words, and no errors. Conversely, a poor homophone would not produce similar numbers of emotionally valenced and 'neutral' words, and an undesirable number of errors. Table 4.8 shows all items ranked according to their respective emotional/neutral difference. The emotional/neutral difference refers to the absolute difference between the emotionally valenced words and their 'neutral' pairs (eg. 'die/dye') and these values are shown in the last column. The lower the value, the closer the emotionally valenced versus. 'neutral' word distribution was, and as explained previously, this was suggested as one of the criteria for the usefulness of items. These values do not take into account the number of errors made however, and the significance of error responses was not known at this stage.

Table 4.8 Items ranked according to emotional/neutral difference.

WORD#	WORD	happy	sad	neutral	errors	abs diff
11	bored/board		55	43	9	12
10	banned/band		14	75	18	12
9	presents/presence	37		61	9	24
14	missed/mist		33	71	3	38
8	bridal/bridle	62		20	25	42
1	medal/meddle	59		15	33	44
2	hymn/him	29		75	3	46
7	heal/heel	71		15	21	56
12	dear/deer	80		23	4	57
15	fined/find		5	77	25	72
16	peace/piece	94		12	1	82
3	die/dye		95	7	5	88
6	mourning/morning	12		88	7	88
5	won/one	7		100		93
18	pride/pried	94			13	94
19	pane/pain		96	1	10	95
17	rose/rows	101		1	5	100
4	sweet/suite	103			4	103

Using these criteria, the best item was the homophone pair (11) 'bored/board' with 55 'sad' (s=55) spellings, 43 'neutral' (n=43) spellings and 9 errors (e=9). Another relatively good item was (9) 'presents/presence' with 37 'happy' (h) spellings (h=37), 61 'neutral' spellings (n=61) and 7 errors (e=7). Other relatively good items were: (14) 'missed/mist' (s=33; n=71; e=3); (2) 'hymn/him' (h=29; n=75; e=3); (12) 'dear/deer' (h=80; n=23; e=4). Items which were rated as the worst in terms of these criteria were: (4) 'sweet/suite' (h=103; n=0; e=4); (18) 'pride/pried' (h=94; n=0; e=13); (19) 'pain/pane' (s=96; n=1; e=4).

The analysis suggested that some items were unsuitable for this South African sample because of differences in the degree of usage and familiarity of some of the words across cultural and home language factors. The most notable examples were seen in the failure of the item (18) 'pride/pried' where no subjects gave the 'neutral' word 'pried', and item (4) 'sweet/suite' where no subjects were able to give the 'neutral' word 'suite'. Little was known at this stage of the possible effects of the I.V. *condition*, and because the criteria for keeping or rejecting items were tentative, further analysis was considered necessary for clarification, and to investigate possible effects.

4.5.5.2 PRINCIPLE COMPONENTS ANALYSIS

A principle components analysis was done as a preliminary step in examining the data, and summarising determinants of variance (varimax rotation method). The variables used were: (subliminal priming) *condition*, *gender*, *language*, total 'happy' scores (*happy*), total 'neutral' words scored in the 'happy' list (*happy/neutral*); total 'sad' scores (*sad*); total words scored in the 'sad' list (*sad/neutral*), total errors made in the 'sad' word list (*sad errors*) and total errors made in the 'happy' word list (*happy errors*). The analysis was set to display factor loadings of >=3 (greater than or equal to 0.3), and selected factors with eigenvalues of >=1 (greater than or equal to 1). These were based on guidelines suggested by Manly (1986).

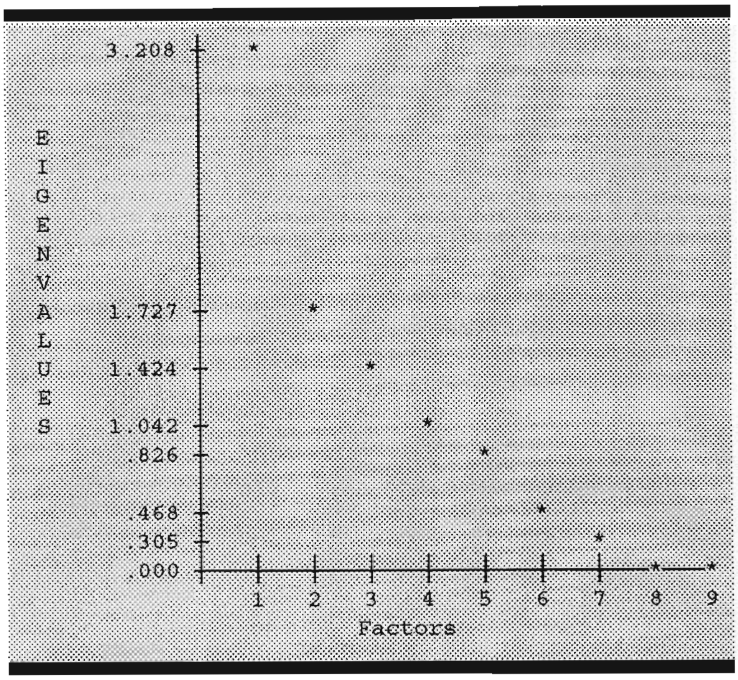

Figure 4.9 Factor plot.

The scree plot is shown in Figure 4.9. Factor 1 (eigenvalue=3.21) accounted for 35.6% of the variance, Factor 2 (eigenvalue=1.73) accounted for 19.2% of the variance, Factor 3 (eigenvalue=1.42) accounted for 15.8% of the variance and Factor 4 (eigenvalue=1.04) accounted for 11.6% of the variance. The total amount of variance accounted for by the 4 factors was 82.2%.

Table 4.9 Rotated factor matrix.

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
HAPPY ERRORS	-.88578			
SAD ERRORS	-.87821			
LANGUAGE	.87243			
SAD		.93012		
SAD/NEUTRAL	.52586	-.79276		
GENDER		.46348		.38651
HAPPY/NEUTRAL			.97149	
HAPPY	.62886		-.72092	
CONDITION				.93060

The rotated factor matrix is shown in Table 4.9 It must be borne in mind that the analysis is not easily interpretable since the variables are not all independent of each other. (See Section 4.5.3.) This can be seen in the case of *happy* and *happy/neutral* variables where there is a negative loading on *happy* in Factor 3, and a positive loading on *happy/neutral*. This is a logical relationship rather than an empirical one since *happy/neutral* is inversely proportional to *happy* because of the compositional nature of the data. This is also true for the variable *sad* and *sad/neutral* in Factor 2. These variables should not be treated as independent causes of variance, but each pair (*happy-happy/neutral; sad-sad/neutral*) should be seen as parts of a single vector. The error variables (*happy errors* and *sad errors*) are independent of each other, but each are constraints on the respective *happy-happy/neutral* and *sad-sad/neutral* components. Naturally the vectors *happy-happy/neutral-happy errors* and *sad-sad/neutral-sad errors* are independent, since they are words from separate lists and have different scoring compositions.

Factor 1 is a bipolar factor and consists of negative loadings on the error variables *happy errors* (errors in the 'happy' list) and *sad errors* (errors in the 'sad' list), and positive loadings on the variables *language, sad/neutral* and *happy*. It could be summarised as 'lack of errors (in both lists), language and tendency to record 'happy' words in the 'happy' list, and 'neutral' words in the 'sad' list. Although one runs the risk of over-interpreting, this could be further reduced to 'linguistic ability and positive selectiveness'.

Factor 2 was also bipolar, and consisted of *sad/neutral* as a negative loading, and the variables *sad* and *gender* as positive loadings. The factor could be described as 'sad word production tendency and gender', or rather roughly as 'sad tendency and gender'.

Factor 3, also bipolar, consisted of a negative loading on the variable *happy*, and a high positive loading on the variable *happy/neutral*. This could be seen as a 'tendency to produce neutral words' and was a relatively pure factor in this regard.

Factor 4 had positive loadings on the variables *gender* and *condition*. The highest loading was produced by the variable *condition* (0.93), signifying that it had the strongest influence in this factor. The factor could be regarded as describing subliminal *condition* and *gender* effects on word selection.

The factor analysis suggested that home language, error proneness and emotional valence in the items were strong determinants of variance in the data. *Gender* and *condition* were also significant determinants, and subliminal priming *condition* seemed to have had the smallest effect.

4.5.5.3 CHI-SQUARE ANALYSIS

Stage 1 of the item analysis suggested that there was considerable variability between items used in the experiment. The measure used to assess items was a coarse one, and did not give any information about their contribution to the variance in the data. The factor analysis established that the independent variables *language* and *gender* were major determinants of variability, and that *condition* contributed to a lesser extent. A chi-square test was done with each item in order to assess the effects of these variables (N=107 in all tests). The approach taken to this analysis was to hypothesize what data trends would occur if there was any subliminal priming effect. In a sense the analysis presupposed that there was such an effect, and the items were analysed to find support for, or disconfirm the prediction of various data trends.

Each item was analysed by the variables subliminal *condition*, *language* and *gender* (three one-way analyses). The chi-square statistic (χ^2) and Cramer's V[15] was calculated (N=107) and the results were ranked in descending order by the size of χ^2. The Cramer's V is a standardised measure of association which takes sample size into account. The maximum value of the statistic is 1, (perfect association) and the minimum value is 0 (no association). It was used because the χ^2 measure of association is more difficult to interpret as a measure of effect size since its value varies with sample size. The results of the analysis are shown in Table 4.9.1.

It can be seen in Table 4.9.1 that the χ^2 statistic values range from 5.64 to nearly 0, and Cramer's V ranges from 0.23 to 0.03. The item with the highest level of significance was (3) 'die/dye' (χ^2=5.64 df=2, p<0.06, Cramer's V=0.23). This was followed by (2) 'hymn/him' (χ^2=4.8, df=2, p<0.09, Cramer's V=0.21), after which there is a rapid decline in the level of significance until item (5) 'won/one' (χ^2=0, df=1, p=1, ϕ=0.03) and (18) 'pride/pried' (χ^2=0,

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[15]The Cramer's V and phi (ϕ) statistic, both measures of association, are identical in the case of a 2X2 table. The Cramer's V statistic was calculated for larger tables.

df=1, p=1, ϕ=0.03).

Carrying out multiple tests of significance makes the adoption of a higher level of significance obligatory since some significant results could be due to chance. It must be pointed out that this was a pilot study which sought to investigate possible effects. There is reason to believe that effects due to subliminal stimulation are small, and highly specific.

Table 4.9.1 Items ranked in order of subliminal priming *condition* effect size (χ^2).

ITEM #	ITEM	Cramer's V/ϕ	χ^2	SIG	RANK
3	die/dye	0.23	5.64	0.06	1
2	hymn/him	0.21	4.8	0.09	2
15	fined/find	0.17	3.2	0.2	3
11	bored/board	0.15	2.29	0.32	4
12	dear/deer	0.13	1.83	0.4	5
19	pane/pain	0.12	1.56	0.46	6
6	mourning/morning	0.119	1.51	0.47	7
16	peace/piece	0.118	1.49	0.47	8
17	rose/rows	0.106	1.2	0.55	9
8	bridal/bridle	0.087	0.81	0.67	10
14	missed/mist	0.082	0.72	0.7	11
7	heal/heel	0.078	0.65	0.72	12
10	banned/band	0.069	0.51	0.77	13
9	presents/presence	0.051	0.28	0.87	14
4	sweet/suite	0.1	0.27	0.59	15
1	medal/meddle	0.03	0.1	0.95	16
5	won/one	0.03	0	1	17
18	pride/pried	0.03	0	1	18

None of the items reached a conventional level of significance, and this means that 'chance' cannot be ruled out as an explanation. Failure to reach significance does not therefore mean that chance is the explanation. The failure to reach conventional significance levels may be due to a small effect size, and the sample size being too small. Indeed, since subliminal effects appear to be small, further investigation is warranted.

Correlation analysis shows that there is virtually no association between the effect size and the absolute difference value calculated in Stage 1 (r=0.0355). This calls into question the usefulness of the *absolute difference index* as an indicator of the value of the items in discriminating between subliminal prime conditions.

4.5.5.4 DETAILED ANALYSIS

Items most likely to reveal subliminal effects were subjected to a more detailed analysis. In this section, items will be analysed in some detail, and data trends will be discussed. The analysis will be presented according to the effect size of subliminal *condition* in descending order of significance. Graphs and tables will give the response variable in brackets. This signifies, in each case, the deviation of word spellings from the expected level as a function of the I.V.

In Section 4.3.4, the expected direction of the data was illustrated in Table 4.6 where the scores on variables *happy, happy/neutral, sad* and *sad/neutral* were predicted as a function of condition. The general expectation was that score changes would be congruent with the respective conditions and emotional valence of the homophones. In some cases however, incongruent responses occurred which were difficult to interpret. Later in section 4.5.5.5 these anomalous items will be discussed further in the light of a further stage of the item analysis.

ITEM 3. DIE/DYE

According to the χ^2 and Cramer's V statistic, this item showed the clearest association with the subliminal variable *condition* (χ^2=5.64, df=2, p=0.059, Cramer's V=0.23). The χ^2 probability verges on the generally accepted significance level of $p<0.05$. The deviation plot is shown in Figure 4.9. This graph shows the deviation (χ^2 residuals) of the words in the 3 categories 'sad', 'neutral', 'error' by subliminal *condition.* This result was considered congruent since in the *sad* subliminal condition, more instances of the 'sad' word spelling were recorded than in the *happy* condition (51 vs. 44, see Figure 4.3).There was a slight tendency for subjects to spell the 'neutral' word 'dye' more in the *happy* condition (4 vs. 3), although this is non-significant (adjusted residuals 0.4 each - see below for an explanation).

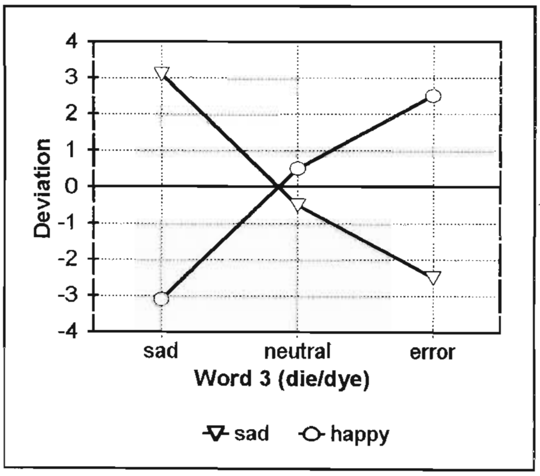

Figure 4.9.1 Deviation of Word 3 by *condition* ('sad').

The adjusted (adjusted to have a normal distribution with mean=0 and SD=1) standardised χ^2 residuals, (referred to henceforth as adjusted residuals) were calculated. This enables a significance test to be carried out (for this thesis: α=0.05) since the 5% standard normal deviate value is 1.96, i.e cells with adjusted residuals of 1.96 or greater are likely to occur by chance less than 1 in 20 times. The adjusted residuals (absolute values) across the variable *condition* (*sad/happy*) for the 'sad' word ('die') were both 1.9, falling just short of significance. The adjusted residuals for the category 'errors' were significant (*sad*:-2.3, *happy*: 2.3) at $p<0.05$. Errors were thus significantly associated with subliminal *condition*. All the errors in this item occurred in the condition incongruent with the meaning of the word (*happy* condition, 'sad' word), and this provided grounds for speculation that errors were associated with incongruent priming.

An effect often associated with *condition* in this study, was the increased number of errors made by subjects in the *happy* condition. This trend was noted in an analysis of variance as a main effect with all 18 items where subjects in the *happy* subliminal condition made more errors than subjects in the *sad* condition. Importantly, this was only significant in the 'sad' homophone list ($p=0.012$). This effect was more pronounced in the interaction of *condition* and *language* factors ($p<0.00009$) in that non-English home language subjects (Group 1) made considerably more errors in the *happy* subliminal condition than English home language speakers (Group 2). The reason why this effect was not seen to any significant extent in the 'happy' homophone list was thought to be due to the finding that items with a 'happy' valence were less affected by subliminal priming. This will be discussed later in section 4.5.5.6. Note also that Group 2 subjects (English) were significantly more likely to give 'neutral' spellings for homophones in the 'sad' list than Group 1 subjects: this is related to the finding that Group 1 subjects made more errors in the 'sad' homophone list than Group 2 subjects since the variables are not independent.

Table 4.9.2 Word 3 by home *language* analysis ('sad').

LANGUAGE--> / WORD3	Count	NON ENGLISH 1.00	ENGLISH 2.00	Row Total
SAD	2	30	65	95 88.8
NEUTRAL	3	1	6	7 6.5
ERROR	4	4	1	5 4.7
	Column Total	35 32.7	72 67.3	107 100.0

Good grounds appear to exist for the speculation that this effect was due to the incongruence of the subliminal prime (*happy*) with the homophone which was most likely to be spelt as 'die' since 89% of subjects spelt this meaning. Because non-English subjects' vocabulary was likely to be less extensive than that of English subjects, they may have had difficulty accessing the other homophone meaning ('dye'), and made more errors as a consequence. This effect is illustrated in Table 4.9.2 where it can be seen that 4 of the 5 errors made were by Group 1 (non-English). In this regard it is also important to note that Group 2 (English) produced disproportionately more 'neutral' words than Group 1 (6 vs. 1). The overall χ^2 word by language test was significant (χ^2=6.21, df=2, p<0.05), and the adjusted residuals (non-English: 2.3; English: -2.3) were significant for the error categories at p<0.05. The standardised residuals are plotted in Figure. 4.9.2. These values represent each cell's contribution to the overall χ^2 statistic for the table. Note that the contribution of errors in the non-English group is the highest in this regard.

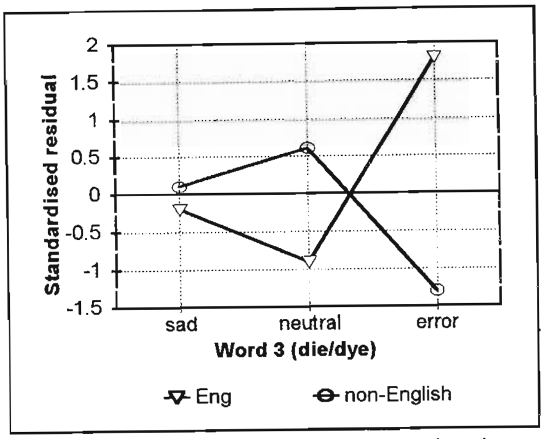

Figure 4.9.2 Residual of Word 3 by language (error).

ITEM 2. HYMN/HIM

This item had the second largest effect size (χ^2 = 4.8, df=2, p=0.09, Cramer's V=0.21). However, the effect of the subliminal *condition* was incongruent. The homophone comes from the 'happy' homophone list, and it was assumed that the word 'hymn' had a happy meaning to the majority of subjects and that its counterpart 'him' was 'neutral'. Therefore it was predicted that the *happy* condition would facilitate the spelling of the word 'hymn' and lessened the likelihood that the 'neutral' 'him' would be spelled. Conversely, it was expected that the *sad* condition would prime subjects to produce the 'neutral' spelling more often than the 'happy' spelling. This was not the case, as Table 4.9.3 shows. The number of 'happy' words spelt in the *sad* condition (condition 1) is greater than that in the *happy* condition (condition 2). Conversely, the number of 'neutral' words spelt in condition 2 is greater than that in Condition 1. This is exactly opposite to the pattern expected, and if the columns 'happy' and

Table 4.9.3 Word 2 by *condition* ('happy').

Count CONDITION->	SAD 1	HAPPY 2	Row Total
WORD2			
HAPPY 1	18	11	29 27.1
NEUTRAL 3	36	39	75 70.1
ERROR 4		3	3 2.8
Column Total	54 50.5	53 49.5	107 100.0

'sad' were transposed, the effect of *condition* would be congruent. It was speculated at this stage that the word 'hymn' was actually seen as a 'sad' word, and 'him' was seen as 'happier'. Figure 4.9.3 shows each determinant of the overall χ^2 statistic by means of the standardised residuals. Note that the *error* category contributed most to the overall effect. None of the adjusted residuals were significant, although the error category was close at 1.8; critical value =1.96.

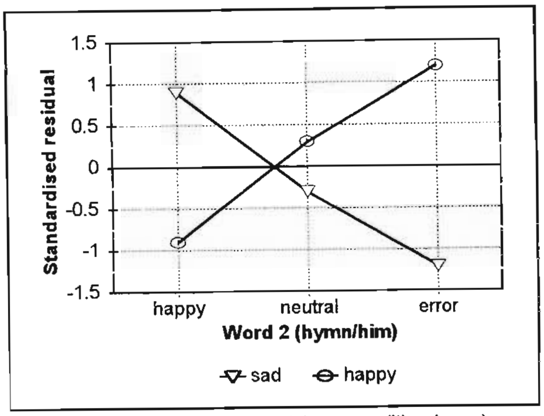

Figure 4.9.3 Residual of Word 2 by *condition* (error).

ITEM 15. FINED/FIND

This item showed the third greatest effect size, but was complex to interpret. The word by *condition* table is shown in Table 4.9.4. Note that the occurrence of the 'sad' word ('fined') is low (4.7%) and that of the 'neutral' word ('find') is relatively high (72%). There were also a large number of errors made (23.4%). There was a large *language* effect in this item (χ^2=45.92, N=107, df=2, p<0.00009) in the word by *language* test.

Table 4.9.4 Word 15 by *condition* ('neutral').

CONDITION-->	Count	SAD 1	HAPPY 2	Row Total
WORD15				
SAD	2	2	3	5 4.7
NEUTRAL	3	43	34	77 72.0
ERROR	4	9	16	25 23.4
	Column Total	54 50.5	53 49.5	107 100.0

If the independent variable, home *language* is taken into account, the picture is different. A series of tables were constructed, to examine the effects of *language*. None of the subjects in the non-English group (Group 1) gave the 'sad' spelling 'fined', and all cases of the 'sad' word were given by the English group (Group 2). Group 2 spelt a total of 5 'sad' words, 64 'neutral' words and 3 errors. A χ^2 test for the effects of *condition* in this group was non-significant (χ^2=0.54, n=72, df=2, p=0.76) In Group 1 however, the word by *condition* test was significant (χ^2=4.97, n=35, df=1, p=0.03, with Yates correction, ϕ=0.44). The adjusted residuals (neutral and errors: 2.6 in each case) were all significant ($p<0.05$).

When the variable *gender* is taken into account, the effect of condition is stronger still. In the female group, there was no change in the pattern associated with *condition* and words were distributed almost evenly between the 2 conditions ($\chi^2=0.44$, $n=88$, df=2, $p=0.44$ Cramer's $V=0.07$). Figure 4.9.4. shows the standardised residuals, which are all small in value and do not exceed 0.4. In the male group however, there was a highly significant effect ($\chi^2=8.74$, $n=19$, df=2, $p=0.013$, Cramer's $V=0.68$) of *condition*. The standardised residuals are shown in Figure 4.9.5. The adjusted residuals for the 'neutral' word between the *sad* and *happy* conditions were significant (2.9, -2.9 respectively, $p<0.05$), and likewise for errors (-2.5, 2.5 respectively, $p<0.05$). The typical pattern of an incongruent result is seen here since the *sad* prime appears to facilitate spelling of the 'neutral' word 'find' instead of the 'sad' word 'fined'.

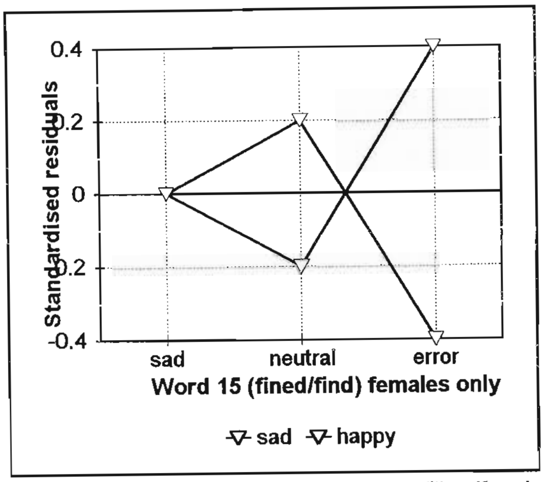

Figure 4.9.4 Residual of Word 15 by *condition* (female group; error).

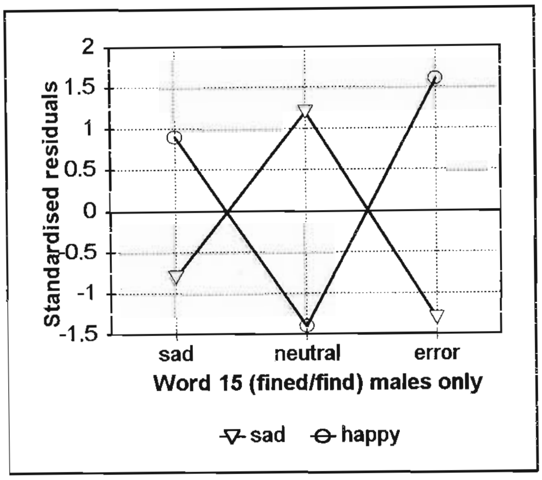

Figure 4.9.5 Residual of Word 15 by *condition* (male group; 'neutral', 'error').

There are also disproportionately more errors in the *happy* condition, which if one takes the previously mentioned incongruent priming hypothesis as an explanation, suggests that subjects were not able to access a word congruent with the prime.

Further analysis examined each group separately (crosstabulation of word by *condition* by *gender* by *language*). The group most significantly affected by the prime consisted of non-English speaking males (Fisher's exact test, 2 tail: $p<0.05$, $n=10$, $\phi=0.82$). There were trends in the same direction in the English male group (Fisher's exact test, 2 tail: $p<0.33$, $n=9$, $\phi=0.5$), and the non-English female group ($\chi^2=0.97$, $p=0.32$, df=1, $n=25$, $\phi=0.28$), but not in the English female group ($\chi^2=0.39$, $n=63$, df=2, Cramer's $V=0.08$).

It may be concluded that there were significant interactions between subliminal *condition* and the independent variables *gender* and home *language*. When these were taken into account, several subgroups were affected to a significant degree by the subliminal priming condition: namely the male group as a whole, and the non-English speaking male group in particular. The effect of the priming however, was incongruent. This suggests that subjects in this group were confused about word spelling, and spelled the word 'find', meaning the negative word, 'fined'.

ITEM 11. BORED/BOARD

A chi-square analysis (N=107) demonstrated that this item showed significant effects of *gender* (χ^2=10.33, df=2, p=0.0057, Cramer's V=0.31) and *language* (χ^2=6.5, df=2, p=0.04, Cramer's V=0.25). In the male group, 21.1% of subjects gave the 'sad' spelling ('bored'), 57.9% gave the 'neutral' spelling ('board'), and 21.1% made errors. In the female group, 58% of subjects gave the 'sad' spelling, 36.4% gave the 'neutral' spelling, and 5.7% made errors. The male group spelled 'board' more often than the female group (although not significantly so: adjusted residual=1.7), but the female group spelled 'bored' significantly more often (adjusted residuals: males= -2.9, females=2.9, p<0.05). The male group showed a nonsignificant effect of *condition* (χ^2=2.87, p=0.24, n=19, Cramer's V=0.39), and this effect size was smaller in the female group (χ^2=0.45, p=0.80, n=88, Cramer's V=0.07).

Between Group 1 and Group 2 (non-English home language and English home language respectively), the number of 'sad' words spelled was comparable (54.3% vs 50%), but Group 1 made significantly more errors (17.1% vs. 4.2%; χ^2=6.54, p=0.04, n=35). The effect size of *condition* observed in Group 1, although nonsignificant (χ^2=4.29, p=0.12, df=2, n=35, Cramer's V=0.35), was stronger than in Group 2 where there was no noticeable effect (χ^2=0.66, p=0.72, df=2, n=72, Cramer's V=0.09).

It is interesting that in the group (non-English) thought to have been affected by the prime (bearing in mind the small effect size), the only noticeable shifts due to *condition* were a slight increase in the number of 'neutral' words recorded in the *sad* condition, and an increase in the number of errors in the *happy* condition. It thus appears that the *sad* prime increased the likelihood of the word 'board' being spelt, and the *happy* prime reduced it, and increased the probability that errors would be made. It may be speculated that for these groups, 'board' was a sadder word than 'bored'. The reason for this is not clear.

The effect associated with the prime condition was most specific to the non-English speaking male sub-group. This may be seen from the chi-square test of Word 11 by *condition* by *gender* by *language* (see Figure. 4.9.6 for a plot of the standardised residuals). In the non-English speaking male subgroup, the adjusted residual value for the 'neutral' word was 2.1 which is statistically significant ($p<0.05$). No other significant results were found for this word.

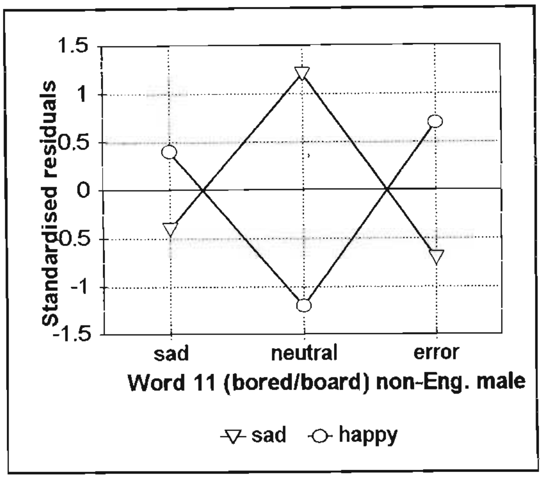

Figure 4.9.6 Residual of Word 11 by *gender* by *language* by *condition* (male, non-English group; 'neutral').

ITEM 12: DEAR/DEER

This item showed a marked effect of home *language* (χ^2=12.46, N=107, df=2, $p<0.002$, Cramer's V=0.34). English speaking subjects (Group 2) made no errors in either prime condition, 72.2% of the responses were 'happy' words ('dear') and 27.8% were 'neutral' ('deer'). Non-English speaking subjects' (Group 1) responses consisted of 11.4% errors, 80% 'happy' words, and 8.6% 'neutral' words. The most noticeable difference was therefore in the relatively low proportion of 'neutral' words recorded by Group 1 (Group 1: 8.6% vs. Group 2: 27.8%). The difference in the proportion of 'happy' words recorded by either group was less (Group 1: 72.2% vs Group 2: 80%), and this suggests that responses were displaced from being 'neutral' ones to errors, since if these were eliminated, the proportion of 'neutral' responses would have been 20% bringing this group closer to Group 2 'neutral' responses (27.8%). It was hypothesized that generally, individuals from Group 1 were less familiar with the 'neutral' word 'deer' than those in Group 2.

There was generally an incongruent pattern of priming in both language groups, and this was seen in an increased number of 'happy' words in the *sad* condition, and a slightly increased number of 'neutral' words in the *happy* condition. There were also more errors recorded by Group 1 in the *happy* condition than in the *sad* condition. The effect of *condition* was small (χ^2=1.83, df=2, p=0.4, Cramer's V=0.13).

ITEM 19: PAIN/PANE

No effect of home *language* was noted in this item, but a relatively strong effect of *gender* was evident (χ^2=5.96, p=0.051, df=2, N=107, Cramer's V=0.23). An interesting gender difference was noted in response to the subliminal *condition*. In Figure 4.9.7 (male group) it may be seen that for the 'sad' category over the two prime conditions, there is a marked deviation associated with *condition* in the 'sad' word category. There were more 'sad' responses in the *sad* condition than in the *happy* condition, and this was a congruent effect. There were also more errors made in the *happy* condition - a finding which is consistent with other 'sad' items, and which was mentioned previously. The adjusted residuals show that these were both significant effects, i.e. for 'sad' and error responses over the *happy* and *sad* conditions ('sad' words: 2.6, -2.6 for *sad* and *happy* conditions), (error: -2.2, 2.2 for *sad* and *happy* conditions). These are all significant at p<0.05. The chi-square test of *condition* in this table is also significant (χ^2=6.97, df=2, n=19, p=0.031, Cramer's V=0.6).

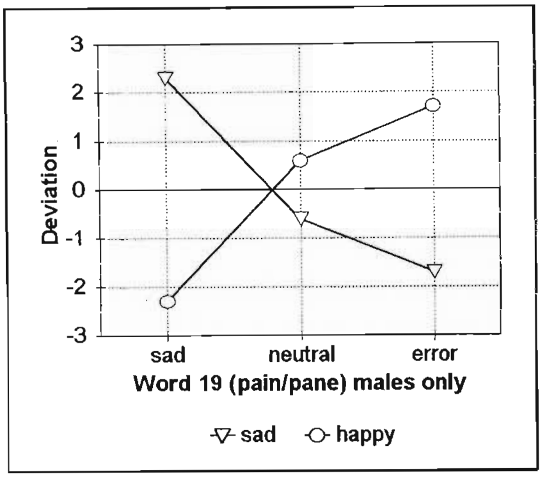

Figure 4.9.7 Deviation of Word 19 by *condition* by *gender* (male group; 'sad').

There were no significant differences in the female group (χ^2=0.004, df=1, n=88, p=0.95, ϕ=0.05), and thus no effect attributable to the priming condition. This item seemed to be sensitive to *gender*, but not language differences. In the male group, there was a significant and congruent response to the prime, and it was hypothesized that this was due to the emotional loading of the item which was somehow salient to this group, and to the *sad* prime. The reason for this gender difference was not known.

ITEM 6 MOURNING/MORNING

Some effect of *language* was observed in this item, but the significance level was relatively low (χ^2=5.2, df=2, N=107, p=0.074, Cramer's V=0.22). The non-English group was more likely to record 'neutral' responses, and less likely to record 'sad' responses than the English group. The adjusted residuals for the 'sad' category (by *condition*) approached (1.9), but did not attain significance (1.96) at p<0.05. Overall, there was a congruent pattern of responses, but the effect size was small (χ^2=1.51, df=2, p=0.47, Cramer's V=0.12). The analysis is shown in Table 4.9.5.

Table 4.9.5 Word 6 by *condition* ('sad').

WORD6	Count	CONDITION: SAD 1	HAPPY 2	Row Total
SAD	2	8	4	12 11.2
NEUTRAL	3	43	45	88 82.2
ERROR	4	3	4	7 6.5
Column Total		54 50.5	53 49.5	107 100.0

ITEM 16: PEACE/PIECE

No clear effects of either language or gender were noted in this item. The significance level of the chi-square test (word by *condition*) was relatively low (χ^2=1.49, N=107, df=2, p=0.47, Cramer's V=0.12) but there was a slightly increased effect size in the word by *gender* by *condition* test in the male group (χ^2=2.59, n=19, df=2, p=0.27, Cramer's V=0.37). The direction of the effect was incongruent in that there were more 'happy' words ('peace') spelled by subjects in the *sad* condition than in the *happy* condition. No clear effects were observed in the other variables. This item was not sensitive to the effects of the prime conditions, and the responses attributable to *condition* were only evident in the male sub-group, and appeared incongruent. These effects were not statistically significant.

ITEM 17: ROSE/ROWS

It was not possible to detect any effects of *condition* in this item and only one 'neutral' response was recorded. This item was probably unsuitable, either because of subjects' apparent unfamiliarity with the 'neutral' word, or its general lack of salience to the priming.

ITEM 8: BRIDAL/BRIDLE

This item showed a highly significant effect of language (χ^2=16.6, N=107, df=2, p=0.0002). This was due to the paucity of 'neutral' responses, and high number of errors in the non-English group (Group 1: 'neutral'=2, errors=16; Group 2: 'neutral'=18, errors=9). Both groups produced more errors than usual.

The priming effect, if any existed, was slight (χ^2=0.88, N=107, df=2, p=0.64, Cramer's V=0.08), but was clearly congruent with the prime conditions in that more 'happy' and less 'neutral' words were spelled by subjects in the *happy* condition, and conversely fewer 'happy' and more 'neutral' words were produced by subjects in the *sad* condition. Subjects made more errors in the *sad* condition (14 vs. 11), and this may have been due to the incongruent priming effect suggested earlier.

ITEM 14: MISSED/MIST

A significant word by *language* effect was noted in this item (χ^2=6.62, N=107, df=2, p=0.04, Cramer's V=0.25) and this reflected differences in the number of 'sad' words and errors made between groups (non-English: 'sad'=26%, errors=8.6%; English: 'sad'=33%, errors=0).

The effect of the subliminal prime on word choice, if one existed, was small (χ^2=0.72, N=107, df=2, p=0.69, Cramer's V=0.08) and incongruent. Slightly more 'sad' words ('missed') were primed in the *happy* than the *sad* condition, and more 'neutral' words ('mist') were primed by the *sad* condition. This item did not seem particularly sensitive to the effects of priming.

ITEM 7: HEAL/HEEL

This item was significantly affected by the variable *language* (χ^2=10.13, N=107, df=2, p=0.0063). The effect was apparent in the relative rates of 'happy' words and errors across home language groups (non-English: 'happy'=51%, errors=37%; English: 'happy'=74%, errors=11%). The effect of *condition* was weak, (χ^2=0.65, N=107, df=2, p=0.72, Cramer's V=0.078). For reasons, perhaps related to salience, this item did not discriminate between subliminal prime conditions.

ITEM 10: BANNED/BAND

This item showed a highly significant effect of *language* (χ^2=31.42, N=107, df=2, p<0.00009), but a low effect of *condition* (χ^2=0.51, N=107, df=2, p=0.77, Cramer's V=0.07). non-English subjects recorded 43% 'neutral' words and 46% errors, while English subjects recorded 83% 'neutral' words, and 3% errors. Thus, non-English subjects produced about half the percentage of 'neutral' words that English subjects did, and made about 15 times the number of errors (these values take the group size into account). It is not clear why this effect occurred, but lack of familiarity and salience were thought to be a likely explanation.

ITEM 9: PRESENTS/PRESENCE

No statistically significant effects of word by *gender* or *language* were noted in this item. There were also no significant effects seen in the word by subliminal priming *condition* test. It was concluded that this item was a poor discriminator of the subliminal prime *condition*.

ITEM 4: SWEET/SUITE

No effects of either *gender* or *language* were seen in this item, and the chi-square analysis of *condition* did not return a significant result (χ^2=0.27, p=0.59). However, the data showed an increased number of errors in the *happy* condition - often present when some priming effect was evident. This item had no 'neutral' responses which suggested that the usage rate of the word 'suite' was relatively low.

ITEMS 1 (MEDAL/MEDDLE); 5 (WON/ONE); 18 (PRIDE/PRIED)

These items will be discussed together in this section since none of them showed any effect of *condition*. Only aspects of interest will be discussed.

Table 4.9.6 Word 1 by *language* (error).

LANGUAGE-->	Count / Exp Val	NON ENGLISH 1.00	ENGLISH 2.00	Row Total
WORD1				
HAPPY	1	6 19.3	53 39.7	59 55.1%
NEUTRAL	3	1 4.9	14 10.1	15 14.0%
ERROR	4	28 10.8	5 22.2	33 30.8%
	Column Total	35 32.7%	72 67.3%	107 100.0%

Items 1 and 18 both showed effects of language (Item 1: χ^2=50.99, p<0.00009; Item 18: χ^2=4.2, p=0.04). The analysis of item 1 is displayed in Table 4.9.6. Note the differences between the actual frequencies (upper row in each cell) and the expected frequencies (lower row in each cell). The number of errors made by non-English individuals was disproportionately high (28), and only one 'neutral' word was recorded. The number of 'happy' words spelled was also relatively low, in comparison with the English group. In item 18, non-English subjects made more errors, and recorded fewer 'happy' words than English subjects. No 'neutral' words were recorded by subjects in either group, and this item was judged to be poor. No effects of either *gender* or *language* were noted in the analysis of item 5. Because of the low to non-existent effect size in the word by *condition* analysis, these items were considered poor discriminators of the subliminal prime *condition*.

4.5.5.5 DISCUSSION OF ITEMS

It was evident in the analysis of these items that the effects of subliminal priming were varied. The premise for this analysis (outlined at the beginning of section 4.5.5.1) was the question 'What patterns would be seen in the data if there was an effect of subliminal *condition?'*. Some of the effects seen appeared to confirm the hypotheses set out in section 4.3.4 and illustrated in Table 4.6, but others were incongruent in that the data showed movement in the opposite direction to that expected. In some items, there was evidence of group-specific effects of subliminal *condition*.

In trying to account for the items which produced an incongruent effect, it is suggested that the emotional meaning of the words was perceived somewhat differently in this subject sample, in comparison with that of Halberstadt *et al.* (1995), and there may have been reversals in the manner in which subjects perceived the words. An example was the item 'hymn/him' which suggested that subjects experienced the word 'hymn' as sad, and 'him' as happy.

Curiously, although the word selection frequency analysis suggested that some items were poor in terms of the criteria set out, the word with the strongest effect size ('die/dye') was ranked 12th in terms of the absolute difference measure (see Table 4.8). This suggested that the item would perform poorly and it was not the case.

There were strong language effects evident in the manner in which subjects spelled words, and non-English subjects were clearly more likely to make errors (especially in the condition which was incongruent with the word's emotional valence), so it appeared that word familiarity was an important factor. It seemed likely too, that a language factor influenced subjects' responses to priming, eg. analysis of item 'fined/find' showed that there was a significant effect of *condition* in the non-English home language group ($p<0.03$).

Gender was also a determinant of word spelling, and there were instances in which there was an interaction with *condition* (eg. there was a strong effect of *condition* ($p=0.031$) in the male group with the homophone 'pain/pane', but none in the female group.

There was agreement between the, factor analysis and chi-square analysis with regard to the effect sizes of the variables home *language*, *gender* and *condition*. It was observed that *language* had a high loading in Factor 1, and *gender* had significant, though modest loadings in Factor 2 and Factor 4. In Factor 4 *condition* had a high loading, and *gender* was represented as a relatively small loading. Since the factors explain diminishing amounts of variance, this fits well with the average χ^2 effect sizes of *language*, *gender* and *condition* (13.08; 2.12; 1.49 respectively).

The chi-square analysis suggested that the effect size of subliminal priming *condition* was relatively small and while some explanations of item performance were offered, further research was needed in order to clarify the relationship between the item characteristics and the effect size. In order to do this, local norms on emotional valence, and usage needed to be collected from a heterogeneous group of subjects in order to be able to investigate *gender* and *language* effects.

The above analysis leads to the following general hypothesis:
The relative strength and type of the emotional valence of items predicts the effect size. The items with the greatest effect size seemed to be the most negative ('die/dye', 'hymn/him', 'fined/find' -see Table 4.9.2). Items in the middle of the range with respect to effect size seemed more 'neutral' ('peace/piece', 'rose/rows', 'bridal/bridle') in comparison. On the other end of the scale (lowest in effect size) items appeared to be more positively valenced ('pride/pried', 'won/one', 'medal/meddle').

The general conclusion from the item analysis was that local norms needed to be collected on the items in order to estimate the emotional valence of the items and clarify the reason that some items had shown incongruent effects. It was hoped that this would also provide further information on the nature of the language and gender differences noted.

4.5.5.6 EMOTIONAL AND USAGE RATINGS

Because of the difficulty experienced in explaining the incongruent reactions of subjects to certain words, a rating scale was designed in order to collect data on each item with regard to emotional valence, and usage.

Subjects were asked to rate each homophone spelling on its relationship to happiness, sadness, and how often it was used personally. An attempt was made to match the sample to that of the subliminal priming study, but this was difficult because of time constraints and the availability of subjects.

Table 4.9.7 shows the sample composition (N=36). Note that non-English (home language) speaking women were in the majority (n=22), followed by English (home language) speaking women (n=8), with an equal number of men (n=3) from each language group. A comparison of the samples from the main study, and item rating study is shown in Figure 4.9.8. A major difference between these samples is that whereas English speaking women were the largest sub-group in the main study (58.9%), in the item rating study, they were the second largest group (22.2%). In effect there was thus a reversal between the non-English speaking and English speaking female groups. The proportion of men, both non-English and English speaking, was approximately the same.

Table 4.9.7 *Language* by *gender* analysis.

GENDER-> Count	MEN 1	WOMEN 2	Row Total
LANGUAGE			
1.00 NON ENGLISH	3	22	25 69.4
2.00 ENGLISH	3	8	11 30.6
Column Total	6 16.7	30 83.3	36 100.0

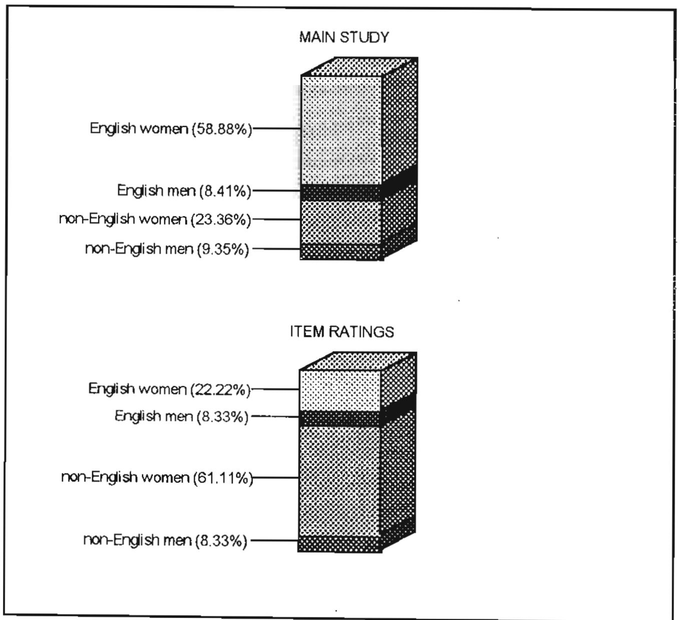

Figure 4.9.8 Comparison of samples.

The questionnaire given to subjects asked them to rate each homophone word on 3 dimensions: (1) relationship to happiness, (2) relationship to sadness, (3) personal usage. A Likert-type scale was used for (1) and (2), and ranged from score *1* 'not at all' related, *4* 'moderately' related, to *7* 'highly' related. The rating range on (3) was from *1* 'never' used, *4* 'sometimes', to *7* 'often'. Data was also collected on the subject's gender and home language.

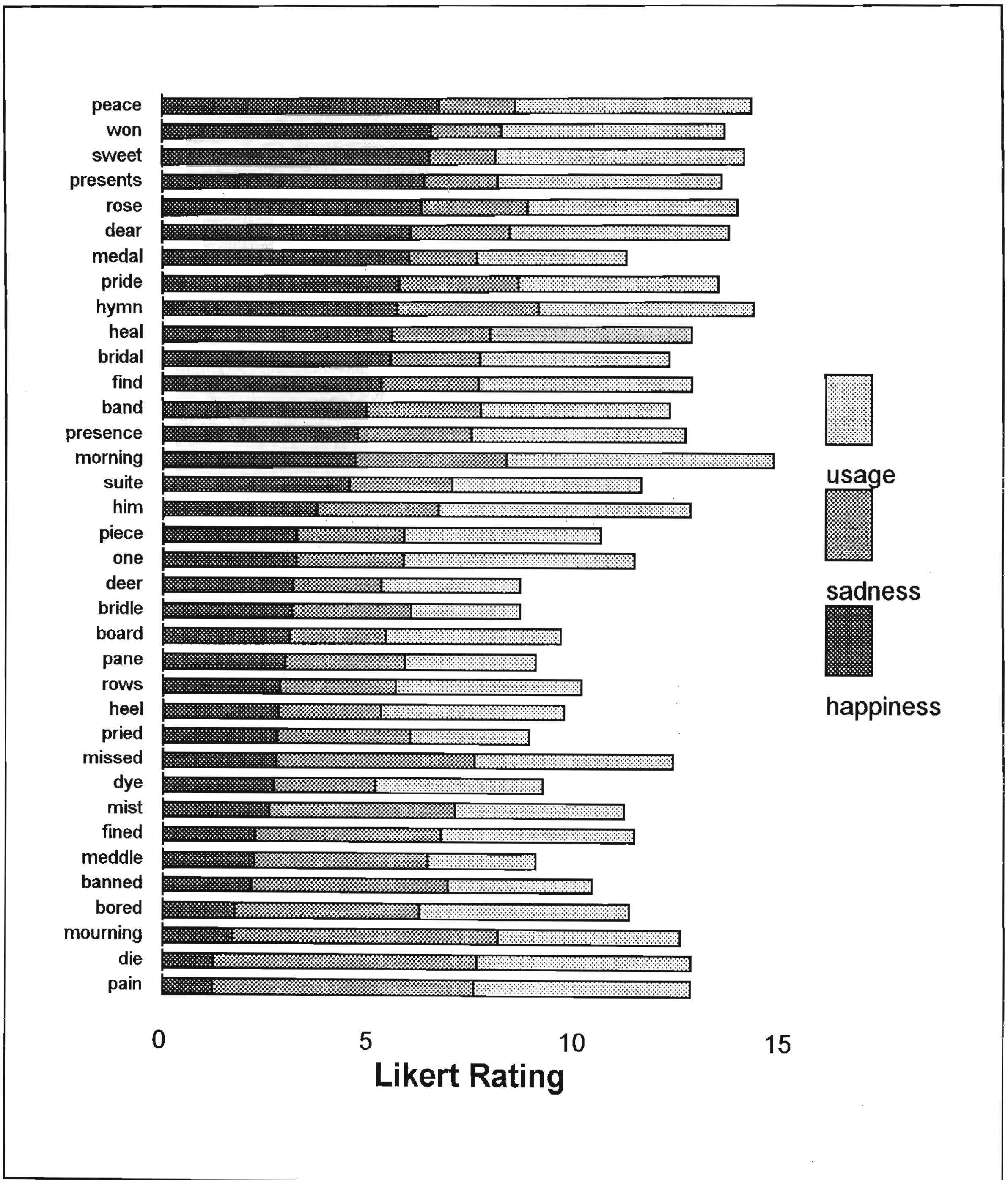

Figure 4.9.9 Item ratings ranked according to relationship to happiness.

4.5.5.6.1 RESULTS

In this section, the word ratings which are of relevance to the items will be presented and discussed. Means were computed for each item on 3 dimensions (relationship to happiness; relationship to sadness; personal usage), and Figure 4.9.9 displays the results with items ranked in order of their relationship to happiness (top to bottom).

The word 'pain' had the lowest relationship to happiness (mean = 1.19), and the third highest relationship to sadness (mean= 6.33). The word 'die' had the second lowest relationship to happiness (mean =1.216), and the second highest relationship to sadness (mean=6.39). These words were therefore well defined in terms of their emotional meaning since they had high ratings in their relationship to sadness and low ratings in terms of their relationship to happiness.

The word 'peace' was rated highest in relation to happiness (mean=6.7), and was fourth lowest in relation to sadness (mean=1.86). The second highest in relation to happiness was the word 'won' (mean=6.51) and was third lowest in relation to sadness (mean=1.7). These items were therefore well defined in their relationship to happiness since they had high ratings in their relationship to happiness and low ratings in their relationship to sadness. One word which was less well defined was 'hymn'. Note the relative relationships to happiness and sadness.

In general, one can see from Figure 4.9.9 that items on either extreme of the graph (top and bottom) are well defined. Towards the middle of the graph, items such as 'bridle', 'pane', 'rows', 'heel' and 'pried' have almost equal, and relatively low ratings on both emotional dimensions. These could be seen as relatively 'neutral' items.

A comparison was made between groups to investigate the effects of gender and home language. This was done by a series of one-way analyses of variance. The results of the comparisons are set out in Table 4.9.8 to Table 4.9.9.2. Levels of significance are shown as follows: where $p <= 0.05$, values are shown in plain type; where $p < 0.01$, values appear **in bold**; where $p < 0.001$, values appear in ***italics and bold***. Discussion of the items, and the effects of home language and gender in relation to the previous analysis will follow.

The small but significant (F=8.4, df=1, p<0.01) difference between language groups found in the analysis of variance (non-English: mean=1.04; English: mean=1.64) in ratings of the word 'die' in relation to happiness was not associated at all with an effect of the variable *condition* in the χ^2 test. There was a slight, but less significant (F=3.19, df=1, p<0.1) difference between these groups in the rating of the word 'dye' (non-English: mean=3; English: mean=1.91). Interestingly, the non-English group also rated 'dye' as more related to sadness (F=3.64, df=1, p<0.06) than the English group (means were 2.83 vs 1.64 respectively). The reason for this was not known, but there was a general tendency for non-English subjects to rate words more highly in relation to emotion than English subjects. Tables 4.9.8 and 4.9.9.1 show this. The language differences did not seem to be associated with word spellings in the homophone task.

Table 4.9.8 Language group comparison: relation to happiness.

	ALL		NON ENG		ENGLISH		P
WORD	MEAN	SD	MEAN	SD	MEAN	SD	
die	1.216	0.63	1.04	0.2	1.64	1.03	0.0064
dye	2.67	1.75	3	1.81	1.91	1.38	0.0827
sweet	6.46	0.99	6.65	0.85	6	1.18	0.0651
suite	4.51	1.82	5.17	1.43	3.09	1.81	0.0009
one	3.22	1.97	3.76	2	2	1.26	0.0115
heel	2.78	2.04	3.38	2.1	1.36	0.92	0.0043
presents	6.33	1.71	6.6	1	5.73	1.35	0.0375
presence	4.7	1.73	5.07	1.52	3.81	1.94	0.0413
board	3.05	2.11	3.56	2.22	1.91	1.3	0.0284
fined	2.22	2.02	2.64	2.29	1.27	0.47	0.0597
find	5.28	2.05	5.64	1.52	4.45	2.84	0.1112
piece	3.24	2.15	3.73	2.2	2.09	1.57	0.0321
rows	2.83	1.61	3.16	1.67	2.09	1.22	0.066
pried	2.75	1.73	3.2	1.83	0.9	0.9	0.0163

The word 'hymn' was ranked as 9th highest in relation to happiness, but 11th highest in relation to sadness (with means of 5.68 and 3.44 respectively). Since the midpoint '4' on the rating scale represented a moderate relationship to sadness, it seems that 'hymn' has a small, but definite relationship to sadness. The word 'him' on the other hand had on average, a lower relationship to sadness (mean=2.94), although it was rated as less happy (mean=3.72). It appears therefore, that there is some support for the hypothesis that there was a reversal in the valence of the words 'hymn' and 'him' whereby 'hymn' was seen as a sad item, and 'him' as less sad. This would explain why the spelling of'hymn' was facilitated by a *sad* prime.

There was a language difference (F=3.79, df=1, p=0.06) in the rating of the word 'fined': non-English subjects rated it higher in relation to happiness (2.64 vs 1.27) than English subjects.

This verged on the significance level of $p<0.05$, and variability was greater in the English group than the non-English group (SD=2.29 vs 0.47). This may be partly explained by the general tendency of non-English subjects to rate words more highly than English subjects. The average relationship to sadness for all subjects was 4.5, which is slightly above the judgement of 'moderately related to sadness'.

Table 4.9.9 Gender group comparison: relation to happiness.

	MALE		FEMALE		
WORD	MEAN	SD	MEAN	SD	p
sweet	5.8	1.33	6.57	0.9	0.101
presents	5.3	1.37	6.53	1.042	**0.019**
find	3.67	3.01	5.65	1.696	**0.029**
piece	4.5	2.6	2.97	2.04	0.117
dear	5.17	1.47	6.17	1.34	0.109
deer	4.5	1.64	2.83	1.39	**0.013**

The average relationship of the word 'find' for all subjects to sadness, was 2.36, and its relationship to happiness was 5.28. There was a non-significant difference ($p=0.11$) between groups whereby non-English subjects rated it higher than English subjects (5.64 vs 4.45). However, there was a significant difference between male and female ratings of the word in relation to happiness. Female subjects' average word rating was 5.65 vs. 3.67 for the male group ($F=5.15$, df=1, $p=0.029$) (see Table 4.9.9).

The ratings can be summarised thus:

1. 'Find' was not neutral, but had a strong relationship to happiness (the mean for the whole sample was 5.28), and a low relationship to sadness.

2. Males rated the word 'find' as less related to happiness than females, and there was a less significant effect of *language* whereby non-English subjects rated 'fined' as happier than English subjects.

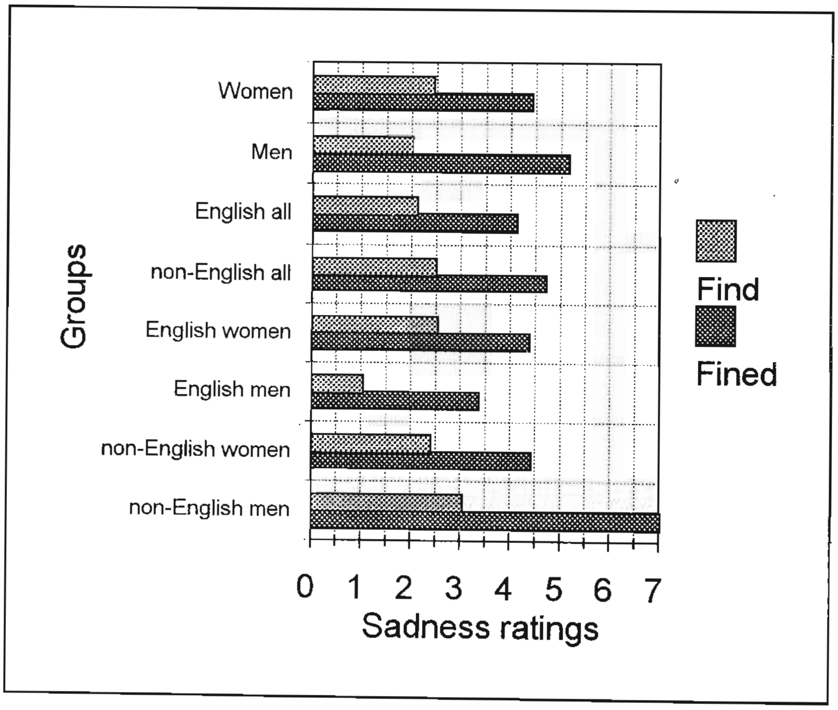

Figure 4.9.9.1 Rated relationship to sadness (group means).

3. A high relationship of both words to sadness predicted an effect of *condition* in the χ^2 analysis (with regard to the various groups: non-English/English, male/female, non-English male). This can be seen **firstly** in the non-English group where mean sadness ratings for both words are slightly higher than those in the English group (*non-English all* vs. *English all* in Figure 4.9.2). The test for *condition* was significant for the non-English group (χ^2 =4.97, df=1, n=35, p=0.03, with Yates correction). **Secondly**, this can also be seen in the comparison of men and women: Figure 4.9.9.1 shows that the sadness scores for the word 'fined' are slightly higher for men than for women, although this is not the case for the word 'find'. The χ^2 test for *condition* in the male group was significant (χ^2 = 8.7, df=2, n=19, p=0.013). **Thirdly**, it can be seen in Figure 4.9.9.1 that non-English men gave the highest average ratings for both words. The analysis of *condition* was significant for this group (Fisher's exact: $p<0.05$, two tail).[16]

It must be emphasized that the differences between the groups on these rating scores are not statistically significant, but represent trends. The manner in which the sadness scores predict the effect of *condition* is not significant from a statistical point of view, but it provides an interesting basis for speculation.

The word 'board' was third lowest in its relationship to happiness (mean=3.05). non-English subjects rated it significantly higher in this regard than English subjects (3.56 vs. 1.91, F=5.24, df=1, $p<0.03$). It was ranked 8th lowest in its relationship to sadness (mean=2.33). 'Bored' was ranked 4th lowest in relation to happiness (mean=1.73), and 9th highest in relation to sadness. The homophone was thus judged to be well defined. No explanation was found in the ratings to account for the incongruence of the reactions to the prime.

The word 'dear' was rated 6th in its relation to happiness (mean=6). There was a tendency for female subjects to rate it higher than male subjects in this regard (6.17 vs. 5.17, p=0.11). On average, the word was not rated as particularly sad (2.42). The word 'deer' was rated significantly higher in relation to happiness by males than females (4.5 vs. *2.83, F*=6.78, df=1,

[16] For a discussion of these statistics, see section entitled 'Item 15. fined/fined' under section: '4.5.5.4 Detailed analysis'.

p=0.013), but not in relation to sadness (mean=1.86).

For male subjects, the closeness of the rating of the word 'dear' (mean=5.17) to 'deer' (mean=4.5) in relation to happiness is problematic. There was a better distinction in the case of female subjects (6.17 vs. 2.83). Another problem is in the relative rates of usage: 'deer' is rated as having the 5th lowest usage - which coincides with a relatively low rate of occurrence ('deer' occurred 23 times, while 'dear' occurred 80 times). The finding that the *sad* prime facilitated, to a small degree, the spelling of the 'happy' word, or conversely that the *happy* prime facilitated the spelling of the 'neutral' word 'deer', may be partly explained by the relatively high relationship of 'deer' to happiness in the male group. However, the item ratings cannot be offered as a completely adequate explanation of this phenomenon.

According to the ratings, 'peace' had the highest relationship to happiness (mean=6.7), and 'piece' was one of the most neutral words (see Figure 4.9.9). One aspect of the rating analysis which may be associated with the priming effect is the finding that males rated the word 'piece' as more highly related to happiness than females (4.5 vs 2.97 - see Table 4.9.9). This was a trend only (p=0.12). No aspect of the rating analysis appeared to predict or explain the incongruent effect of the prime, and this explanation seems inadequate.

The word 'mist' was rated as slightly sadder than 'missed' (4.5 vs. 4.8) and 'missed' was related as slightly happier than 'mist' (2.73 vs. 2.56). A t-test shows that in terms of both sadness and happiness, the words were not significantly different from each other (sadness: t=0.58, df=35, p=0.56; happiness: t=0.44, df=35, p=0.66). The behaviour of this item can thus not be predicted in relation to the prime conditions by the rating analysis.

The usage ratings of the word 'suite' suggested that it had a relatively low rate of usage (mean for all subjects=4.6). non-English subjects rated it significantly higher in relation to happiness than English speakers (5.17 vs. 3.09, F=13.36, df=1, p<0.0001). This is of academic interest however, since the word was not spelled by any of the subjects in the main study. The word 'sweet' was rated 3rd highest in relation to happiness (mean=6.46), and there was a tendency for English subjects to rate it higher in relation to happiness than non-English subjects (see Table 4.9.9.1).

Comparisons of word ratings for sadness and usage across home language groups are given in Table 4.9.9.1 and 4.9.9.2 mainly for interest's sake.

Table 4.9.9.1 Language group comparison: relation to sadness.

	ALL		NON ENGLISH		ENGLISH		
WORD	MEAN	SD	MEAN	SD	MEAN	SD	p
medal	1.64	1.13	1.38	0.75	2.27	1.62	0.027
dye	2.46	1.79	2.83	1.93	1.64	1.12	0.065
sweet	1.61	1.08	1.4	0.86	2.09	1.37	0.075
bridle	2.89	1.41	3.34	1.23	1.82	1.25	0.001
rows	2.8	1.75	3.2	1.8	1.91	1.3	0.04
pane	2.91	1.6	3.33	1.55	1.9	1.28	0.015

Table 4.9.9.2 Language group comparison: usage rating.

	ALL		NON ENGLISH		ENGLISH		
WORD	MEAN	SD	MEAN	SD	MEAN	SD	p
him	6.11	1.68	5.8	1.89	6.8	0.603	0.095
one	5.6	1.8	5.2	2.02	6.6	0.67	0.0286
presents	5.42	1.63	5.72	1.69	4.73	1.27	0.09
banned	3.47	1.63	3.08	1.49	4.36	1.63	0.0273
band	4.57	2.01	4.15	2.01	5.54	1.69	0.05
bored	5.1	2.09	4.73	2.16	6	1.67	0.092
rose	5.08	1.6	4.77	1.45	5.82	1.77	0.0685
pain	5.25	1.89	4.8	1.92	6.4	1.26	0.02

Understandably, all words tend to be used more by English speakers than non-English speakers except for the word 'presents' where the opposite tendency is seen.

Some considerations in the interpretation of the item ratings should be pointed out. The conditions under which subjects rated the words were different to those under which the subjects were given the homophone task in at least 2 ways:

1. Subjects were under little time pressure in the word rating task, whereas in the homophone task, they were intentionally given time constraints. Subjects in the former situation had time to think about their word choices, but in the latter situation, subjects were asked to type the first response that came to mind. This was similar to the approach which Halberstadt *et al.* took (see Halberstadt *et al.*, 1995, p. 279). It is possible in the word rating task that subjects were affected by a response set, whereas in the main study, it was hoped that this was true to a lesser extent.

2. Subjects doing the word rating task had both spellings of the homophone available, and would therefore have been more aware of the different word meanings. Less potential for confusion about the word meaning therefore existed in the word rating task.

The implication of these observations is that the differences observed in the word rating data may have been accentuated in the homophone test session.

4.5.5.7 WORD RATINGS AND SUBLIMINAL MOOD PRIMING EFFECTS

In the previous section, some suggestions based on the word rating analysis were made, but conclusive explanations could not be found for the priming effects which were incongruent in some items. This section will present findings which indicate that a relationship exists between the effect size of the subliminal prime and the ratings of the words. This gives a useful basis for speculation on the characteristics of homophones which were sensitive to priming effects, and perhaps on the nature of the subliminal priming effect.

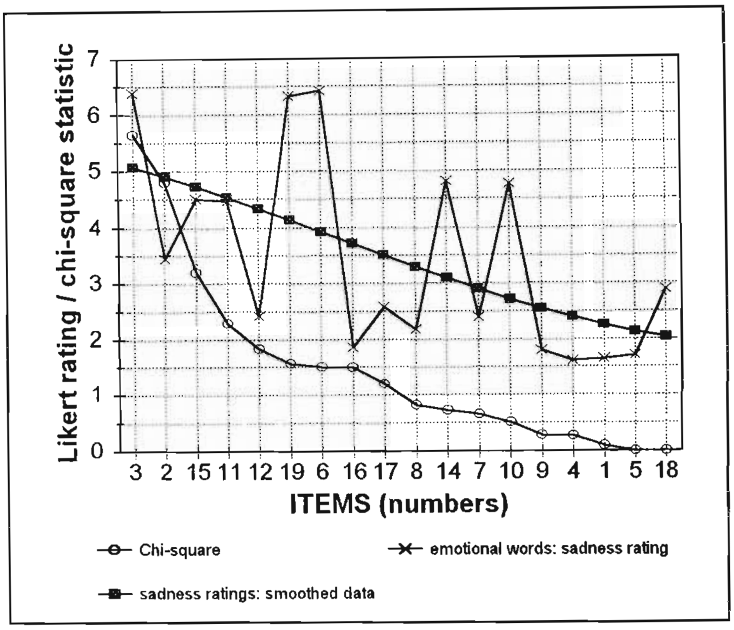

Figure 4.9.9.2 Plot of χ^2 statistic and word sadness ratings.

It was noted previously that as the effect size diminished in the item list (ranked in order of effect size), the emotional valence of the words seemed to change - roughly from being clearly negative at the beginning of the list, to neutral in the middle of the list, to being noticeably more positive at the end of the list. Figure 4.9.9.2 shows a plot of the χ^2 statistic (word by *condition*) for all homophones (lower line) and the sadness rating of all valenced, i.e. non-neutral words (upper line). Superimposed on the upper line is a plot of the same data after smoothing using the polynomial method (third order). Items on the X-axis are ranked according to the magnitude of the χ^2 statistic (all χ^2 analysis is based on N=107). Units on the Y-axis represent both rating scale units, and the χ^2 statistic. Note that there is a downward trend in the word sadness ratings, this is shown clearly by the smoothed data line. This is obviously not a time series, and the fit is quite poor. Extrapolation from the smoothed data would therefore be unreliable, and because of the way it is employed, it would be non-meaningful. The plot of the smoothed data is given for the purposes of illustration only, and not for the purpose of statistical inference.

The χ^2 statistic is used in preference to the Cramer's V in the graphs simply because the range of the latter is more compressed (from 0.03 to 0.22) than that of the χ^2 values (0 to 5.64). *N* was the same for all item analyses, and the correlation between the effect size measured by the χ^2 and Cramer's *V* statistic is close to perfect (r=0.96).

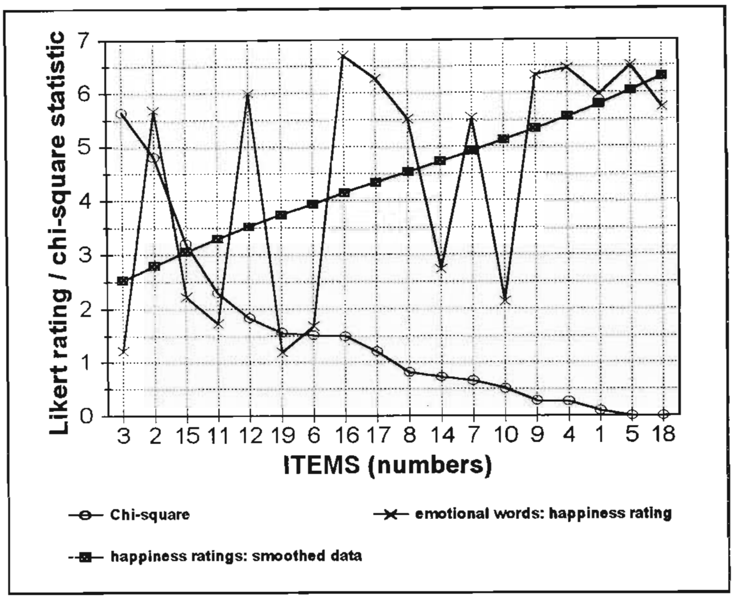

Figure 4.9.9.3 Plot of χ^2 statistic and word happiness ratings.

Figure 4.9.9.3 shows plots of the ratings of all emotionally valenced words in relation to happiness, the χ^2 statistic, and the smoothed data of the happiness ratings. The same third order polynomial smoothing method was used. Note the upward trend of the fitted line in the direction of happiness.

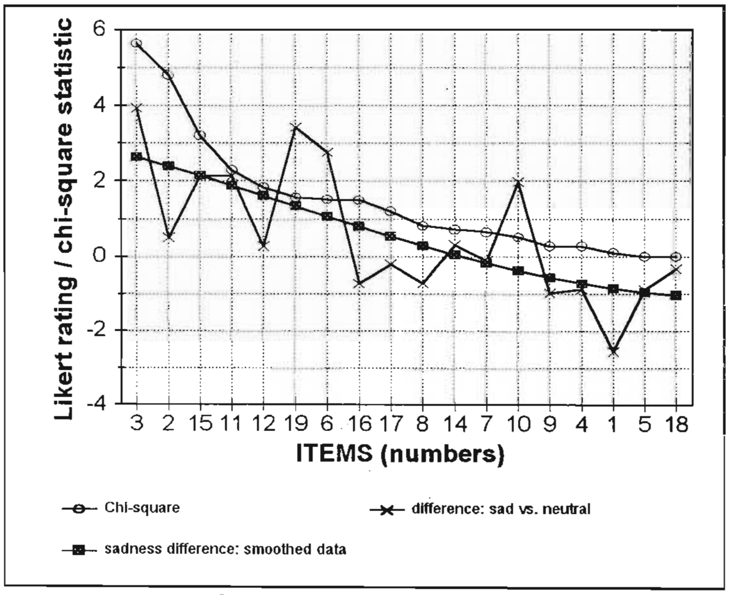

Figure 4.9.9.4 Plot of χ^2 statistic and 'sad/neutral difference values'.

Figure 4.9.9.4 shows the plot of the difference between the sadness ratings of all emotionally valenced words, and their 'neutral' counterparts[17] (eg. The difference in rated sadness between the word 'die' and its 'neutral' counterpart 'dye'), the smoothed data, and the χ^2 statistic. The difference scores will be referred to as the 'sad-neutral difference values' for ease of explanation. Note that the fit between the difference values and the smoothed data is better than that between the sadness ratings and the smoothed data.

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[17] Signifying: Mean sadness rating$_{\text{valenced word pair}}$ - Mean sadness rating$_{\text{neutral word pair}}$

The data displayed in the previous graphs tends to support the impression that there was a change of emotional valence which was associated with diminished effect size. A correlation analysis (Spearman Rank Correlation) was done to estimate the degree of the relationship between these variables and its significance. The following were of interest:

1. There was a negative correlation between the happiness ratings of the emotionally valenced words and the Cramer's *V* statistic ($r = -0.44, p=0.07$).

2. There was a significant positive relationship between the sadness ratings of the emotionally valenced words, and the Cramer's *V* statistic ($r =0.53, p=0.03$).

3. The correlation between sad-neutral difference values and the Cramer's *V* statistic was highly significant ($r =0.73, p<0.01$).

It is concluded that a major determinant of variability in the items with respect to subliminal condition in the items was their emotional valence. Correlations support the impression gained earlier, that the effect size was related to the emotions associated with the homophone pairs. A strong effect size is associated with a negative, or sad emotional evaluation, and a weak effect size is associated with happy emotional evaluation. A relationship which was even stronger than this is seen in the correlation between the sad/neutral rating difference and the effect size. In other words, a large effect size was associated with both a large difference between the sadness ratings of the homophone pairs (eg. 'die/dye': 3.9 was a large difference and this item showed a large effect size; and 'pride/pried': 0.34 was a small difference, and this item showed no effect) and the degree of sadness with which the emotional homophone pair was rated. In short, if the sadness rating of the emotional homophone was high and the sad/neutral difference was large, a subliminal priming effect was likely to occur.

The rating analysis was of some use in explaining why some of the items elicited incongruent responses. There was support from the ratings for believing that item 2 'hymn/him' had functioned as a 'sad' word, and there was also some evidence to show that the sadder the words 'fined' and 'find' were rated, the more likely the homophone would be to show an effect of *condition*. This is consistent with the general finding of a relationship between rated sadness and effect. The difficulty with this finding is the incongruence of the reaction to the priming with this homophone. The other item for which the rating analysis was helpful was the pair 'sweet/suite'. It was pointed out that the rate of usage of the word 'suite' was generally quite low, and familiarity was thought to be a possible factor. No correlation was found between usage rate and effect size however.

The main difficulty experienced in analysing the results of this study, was thought to result from the variability between items in terms of emotional valence. Thus, some items behaved as predicted, and others in the opposite manner and the effects of priming were probably cancelled out when all items were analysed together. Generally, the data was probably sullied by effects of gender and especially home language, since the non-English group was especially prone to making errors.

In the ANOVA analysis of all 18 items, the null hypothesis had to be accepted for the variables *happy, happy/neutral happy errors,* and *sad* since there were no significant differences in scores between the two subliminal mood-priming conditions. Clear main effects of subliminal priming *condition* and interactions with *gender* and *language* were seen for the variables *sad errors* and *sad/neutral* however. When a detailed item analysis was done, similar evidence was found for a priming effect in the individual items, where associated changes in word spellings and the production of errors were seen. The item analysis also showed that specific language and gender effects were present, and that there were interactions with subliminal priming condition, eg. the item 'fined/find' showed a marked effect of language and gender, and the item 'pain/pane' showed an effect of gender only.

Several indications point to the conclusion that the emotional valence of items determined the extent to which they were sensitive to the effects of subliminal priming. It is understandable that a significant determinant of sensitivity was the sadness rating of the item since this would be linked to the nature of the priming stimulus. There did appear to be small congruent effects in the case of 'happy' homophones ('bridal/bridle'; 'presents/presence'), but the priming effects with these items were relatively small (Cramer's V=0.087, p=0.67; Cramer's V=0.051, p=0.87 respectively), and possibly reflect mere randomness.

4.6 AWARENESS CHECK

In the *happy* subliminal condition, 5 subjects recalled the word 'happy' in the recall test, but no subjects exposed to the *sad* stimulus recalled any words related to the prime. The data is given in 'Appendix I' for the interested reader. It is not clear why none of the subjects recalled any of the words from the 'sad' phrase. This will be discussed further in Chapter 7.

4.8 DISCUSSION AND CONCLUSION

This experiment was designed to test the hypothesis that subliminal mood priming could influence the resolution of lexical ambiguity in a direction consistent with the priming. Some support was found for a subliminal effect by means of an ANOVA, item analysis and word rating survey, but the magnitude and direction of the effect varied between items.

It is argued that a subliminal priming effect was obtained in this study although the nature of this effect was different in some respects to that expected. Priming was expected to facilitate the spelling of 'sad' words in the *sad* condition, and 'sad/neutral' words in the *happy* condition. This would be a congruent type of priming and to test for this effect, significance tests were done in the item analysis with the adjusted residual values for each word category (eg. sad, neutral or error) between priming conditions. Some evidence for congruent priming was found for the whole subject sample, eg. item 3 ('die/dye') showed an increase in the production of the word 'die' in the *sad* condition, but the adjusted residual (1.9) was slightly less than the critical value (1.96). Group-specific effects of congruent priming occurred for the item 'pain/pane' where the adjusted residuals for the 'sad' category were significant ('pain': 2.6, -2.6 for *sad* and *happy* priming respectively), and the item 'mourning/morning') approached significance for the 'sad' category ('mourning': 1.9, -1.9 for *sad* and *happy* priming respectively). It is interesting that these words are the most clearly related to sadness (see Figure 4.9.9). Indeed, 'pain' is rated highest in relation to sadness, followed by 'die' then 'mourning'. It seems possible to conclude that these congruent effects are related to the intensity of the sadness ratings. This pattern also makes it less likely, given the correlation between effect size and sadness rating, that these changes in the frequency of 'sad' word spelling are simply due to randomness.

It may be concluded that apart from what seemed to be specific congruent priming effects, (measured by testing the adjusted residual value of the word category in the χ^2 analysis), the evidence suggests that a number of non-specific subliminal priming effects were more generally seen (appearing as word by *condition* effects where a clear, congruent pattern of priming was not seen). These effects seemed to occur with items whose emotional valence was less clear. A non-specific priming effect most commonly seen was an increase in the number of neutral words in the *sad* subliminal priming condition. This was seen almost exclusively in the 'sad' homophone list, with the exception of the word 'hymn' which, according to the item rating analysis seemed to behave as a sad item. Another non-specific priming effect was seen in the increased number of errors made in the 'sad' word list in the *happy* priming condition. This may be the result of incongruent priming since these were sad items and the subjects were exposed to a happy priming stimulus. Where they were unable to access a meaning congruent with the prime, subjects may have tended to make errors. This was predicted by Greenwald *et al.* (1995), although these authors did not find strong evidence for it.

In short, the following conclusions seem warranted:
1) There is evidence to show that item sensitivity to subliminal priming varied according to emotional valence. Generally a high sadness rating predicted a subliminal priming effect. This constitutes support for the hypothesis that word selection frequency varied non-specifically (as defined above) as a function of subliminal condition.
2) There is some support for the hypothesis that mood-congruent priming would occur, and the items where congruent priming occurred were the most clearly defined in terms of emotional valence.

The item rating study appears to throw light on conclusion 1, since a statistically significant correlation was found between the sadness ratings of the valenced words in each homophone pair and the effect size (r = 0.53, p<0.05). This relationship indicates that the effect size diminishes as a function of the rated sadness of the valenced words. This finding may be related to that of Halberstadt *et al.* who observed that a 'sad' mood manipulation stimulus was associated with a significant increase in the production of 'sad' words (p<0.005), but did not find any change in the production of 'happy' words (p. 280-281).

A closer relationship was found between the effect size (r = 0.73, p<0.01) and the difference in the sadness ratings between valenced and 'neutral' homophones. This suggests that the more distant the word pairs were from each other in terms of their sadness ratings, the higher the effect size was. It is also suggested therefore, that important properties of homophones for this purpose, are:

1. The rated sadness of the emotionally valenced word;

2. The emotional difference between the word pairs in terms of sadness ratings.

These findings appear to constitute criteria for the sensitivity of the homophones to subliminal mood priming.

The data produced in this study was complex, and modest support was found for the hypothesis that subliminal mood suggestion, using the masking by visual noise technique, affects word spelling in a homophone spelling task. Items in the homophone list varied considerably in their sensitivity to subliminal priming, and some items behaved in an anomalous manner. It is concluded that tentative criteria were established for the selection of appropriate homophones for this type of task.

The pattern of the priming effects, and the correlations between word ratings and effect size suggest that the findings of this study do not reflect mere randomness. The fact that all the significant effects were seen in the 'sad' homophone list (apart from those items which were anomalous, and where there was arguably a reversal in meaning), together with the correlation between effect size and sadness ratings suggests that there is a relationship between negative subliminal mood priming and subjects interpretation of ambiguous stimuli. This is rendered more plausible by the negative correlation between the happiness ratings of the words and the effect size, since these are independent of the sadness ratings. Another strong correlation which supports this is that between the sad/neutral difference ratings and the effect size. There appears to be no effect of positive subliminal mood priming in this study, and it appears that subjects did not react to positive stimuli.

The clearest effects of mood priming, (where production of congruent words was facilitated) were seen when the emotional valence of the relevant words was most clearly defined as sad. These results are not altogether secure from a statistical point of view since multiple tests of significance were done, but the pattern of results makes them more plausible. Significant non-specific priming effects were found in the 'sad' homophone list where subjects tended to produce neutral words when exposed to a *sad* subliminal stimulus, and produced more errors when exposed to the *happy* priming stimulus.

5. FOLLOW-UP STUDY

5.1 INTRODUCTION

The question this research sought to answer is, 'Does some clear change in mood occur through subliminal suggestion and, if so, can it be reported directly, or would it have to be inferred indirectly through some pattern in the data?'

In the Main Study, some evidence was produced that priming had occurred without conscious awareness. While interpretation was complicated by gender and home language factors, evidence was considered that effects of mood priming were present. The evidence is summarised below.

The strongest effect for the priming was mood-congruent. This was seen in participants' responses to sad subliminal mood stimuli which facilitated the production of sad homophones. The effect of the negative stimulus was much stronger than that of the positive stimulus (i.e. for the facilitation of positive words) and this was concluded from the following observations:

1. A significant correlation (r=0.53, p<0.05, 2-tailed) between the rated valence of the sad words and the effect size[18] indicated that words (eg. 'die', 'pain', 'mourning') with a high sadness rating were more sensitive to the effects of subliminal condition than others.
2. A weak negative correlation was found between the happiness ratings of the words and the effect of subliminal condition (r=-0.44, p<0.1, 2-tailed).
3. When the neutral word ratings were subtracted from the sad word ratings, the correlation was stronger (r=0.73, p<0.01 2-tailed).

This pattern of correlations suggests that word items with high sad ratings and low happy ratings were sensitive to below threshold mood priming. Items which were rated as positively valenced or neutral, were not sensitive.

The question which this experiment sought to address concerns the effect of sub-threshold mood priming on subjects' mood. While some evidence of mood-congruent priming effects exists (Kemp-Wheeler and Hill, 1992) it is not clear if subjects actually experience a change in

[18]Based on the *Cramers V* statistic

mood and if so, whether this change could be reported subjectively, or measured using some kind of self-report mood scale. In their experiment, Halberstadt *et al.* (1995) assessed subjects' mood by means of the Brief Mood Introspection Scale and excluded those who had not been influenced by the mood manipulation. They thus had a means of validating the effects of the mood manipulation. In the published subliminal research, it does not appear that **direct** measurement of a subliminally induced mood has been attempted. The effects of subliminal interventions seem, in the literature, to have been inferred exclusively from indirect effects. One would suppose that logically, this is because subliminal manipulations are assumed (by definition) to occur without awareness. However, I wondered, if some mood measure was directly made, whether any kind of measurable change would occur that could be related to the subliminal intervention.

In this chapter, a Method section will describe the subjects, design, subliminal priming stimuli, procedure and variables used in the follow-up experiment. A Results section will present the findings and statistical analysis, and these will be discussed briefly and summarised in the Conclusion section. The findings will be discussed more generally in Chapter 7 (entitled 'Discussion and Conclusion'.

5.2 METHOD

5.2.1 SUBJECTS AND DESIGN

Nineteen undergraduate psychology subjects either volunteered, or were approached to participate in this experiment. Initially, subjects were chosen at random from 3 groups which were formed on the basis of a cluster analysis in the Main Study[19] and invited to participate. Of those selected, 11 volunteered. An additional 8 students were then approached, and asked to participate. The subject group comprised 19 women, of whom 3 did not speak English as a home language. The subjects were approached because they resided in the Pietermaritzburg area during the vacation, and were available during the winter vacation. A number of men were

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[19] Initially it was thought that there was an important between-subjects effect of subliminal stimulation, and the clusters were labelled 'Sensitive', 'Paradoxical' and 'Non-sensitive'. As the labels imply, it was thought that some subjects reacted congruently to the stimulation, others reacted incongruently, and other subjects did not react at all. The cluster solution was abandoned when it proved to be unsound.

randomly selected for the study, but of those that volunteered, none responded to the follow-up contact.

No remuneration was given, except where the subjects had to travel from another city to the Pietermaritzburg Psychology Department. Subjects were later sent written feedback in the form of a brief report on their responses in the experiment.

It is possible that some bias existed in the selection of participants for the Follow-up study. The group consisted only of females, and those who volunteered may have done so on the basis of their interest in the subject. This will be considered in section 5.4.1.

The participants were randomly assigned to either a negative or positive mood stimulus group. This was done by the computer program which randomly assigned each subject either a '1' or a '2'. When a subject was assigned to condition '1', she was exposed to a negative mood stimulus, and when assigned to condition '2', she was exposed to a positive mood stimulus. This was done without the knowledge of either the subject or the experimenter, thus a double blind condition was achieved.

The independent variable was thus subliminal *condition*, and the dependent variable was scores on the Profile Of Mood States (POMS) (McNair *et al.,* 1992). This test was administered before and after the subliminal mood suggestion procedure.

A shortened (12 item - i.e. the 12 best test items) version of the General Health Questionnaire (GHQ) (Goldberg, 1972) was administered first as a control for the pre-existing effects of psychiatric status. This scale gives a measure of psychiatric disturbance for the purpose of case identification.

5.2.2 TEST MEDIUM

Both questionnaires were administered on computer, and all data recorded from subjects was stored on disk. Thus, no interaction was necessary between the experimenter and the subject once she was seated at the computer. The program source code was written in *Pascal*, and the compiled program was run on an *IBM*-type *80486* machine under the *DOS 6.0* operating system (see Appendix D).

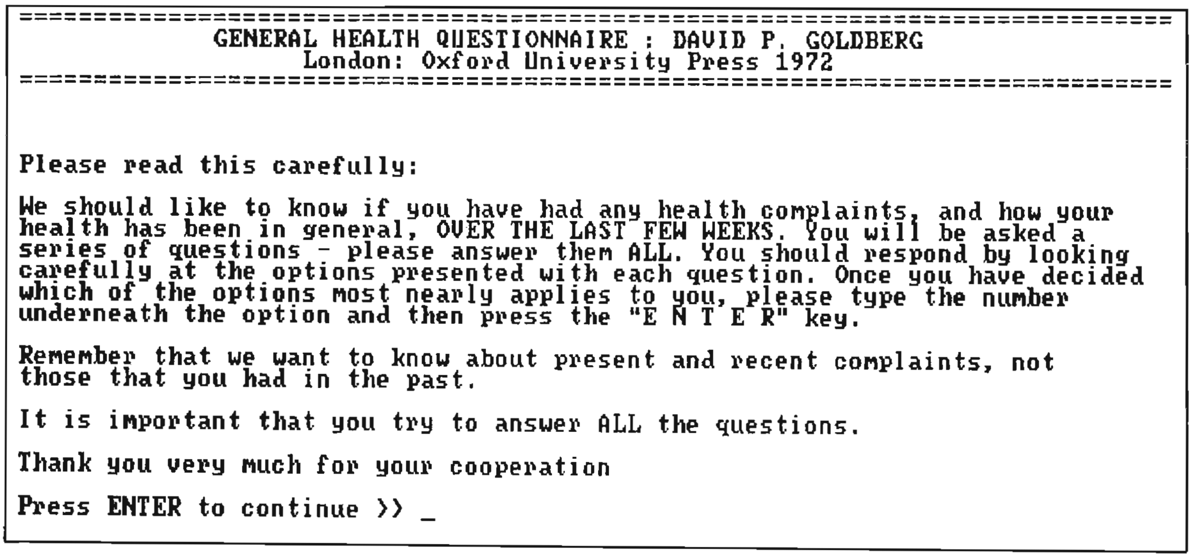
The computer program administered the tests, recorded and scored the data, performed the subliminal exposure and randomly determined the subliminal *condition* that each subject was assigned to. Instructions, prompts and examples were displayed at various points in the program.

5.2.3 SUBLIMINAL PRIMING METHOD

In the Follow-up Study, subliminal mood suggestion was done by means of exposures to phrases below the subjective threshold. The same threshold which was determined at an earlier stage of this research (described in the chapter entitled 'Pilot Study') was used (9.5 ms). The same method of backward masking by visual noise was used, although the mask was altered slightly (after pre-trials) to reduce recognition rates, without changing the exposure time. The mask is illustrated in Figure 5.1. The characters used for this mask were randomly selected from *ASCII* characters 232 to 241 using the *IBM* character set.

Figure 5.1 Modified visual noise mask.

The phrase designed to induce a negative mood was 'SAD AND ALONE', and that designed to induce a positive mood was 'HAPPY AND FRIENDLY'. These were presented in upper case for 9.5 ms, and were programmed to be displayed 15 times.



GENERAL HEALTH QUESTIONNAIRE : DAVID P. GOLDBERG
London: Oxford University Press 1972

Please read this carefully:

We should like to know if you have had any health complaints, and how your health has been in general, OVER THE LAST FEW WEEKS. You will be asked a series of questions - please answer them ALL. You should respond by looking carefully at the options presented with each question. Once you have decided which of the options most nearly applies to you, please type the number underneath the option and then press the "E N T E R" key.

Remember that we want to know about present and recent complaints, not those that you had in the past.

It is important that you try to answer ALL the questions.

Thank you very much for your cooperation

Press ENTER to continue >> _

Figure 5.2 Instruction screen for GHQ.

5.2.4 PSYCHOMETRIC MEASURES

5.2.4.1 GENERAL HEALTH QUESTIONNAIRE

The GHQ is commonly used as a screening instrument, and was used in the Follow-up Study in order to identify cases of psychiatric illness. The 12-question version was adapted for computerised administration. Subjects were asked to answer questions on the status of their health over the last few weeks, i.e. present and recent complaints. The instructions were given on an introduction screen shown in Figure 5.2. The items were answered on a Likert-type scale between 1 and 4. Question 1 of the GHQ is displayed in Figure 5.3. Note that all questions take the form 'Have you recently' followed by the item, eg. 'Been able to concentrate on whatever you're doing?'.

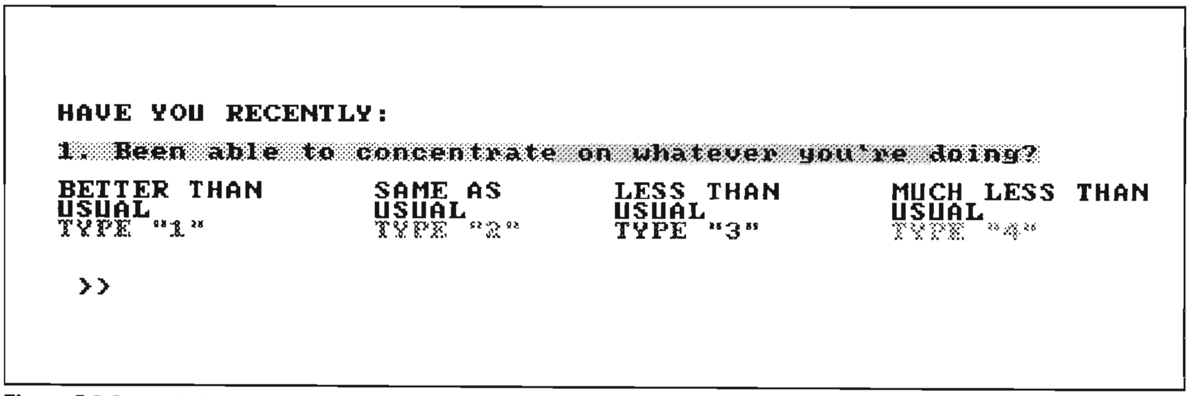


Figure 5.3 Computerised form of the questions and rating scale.

The procedure was explained to each subject beforehand, and she was guided in the initial stages of the experiment. The subjects were encouraged to ask questions at any stage, and the experimenter was available at all times.

A list of the 12 questions used is given in Table 5.1.

Table 5.1 GHQ items.

1	Been able to concentrate on whatever you're doing?
2	Lost much sleep over worry?
3	Felt that you are playing a useful part in things?
4	Felt capable of making decisions about things?
5	Felt constantly under strain?
6	Felt that you couldn't overcome your difficulties?
7	Been able to enjoy your normal day to day activities?
8	Been able to face up to your problems?
9	Been feeling unhappy and depressed?
10	Been losing confidence in yourself?
11	Been thinking of yourself as a worthless person?
12	Been feeling reasonably happy, all things considered?

Responses to the items were recorded and scored on completion of the GHQ. Two totals were calculated: a 'Simple Likert Scoring Method' where responses were scored 0-1-2-3 (derived from the 1-2-3-4 item responses respectively), and a GHQ scoring method (0-0-1-1). These methods were suggested by Goldberg (1972) who found that the GHQ scoring method was superior with respect to case identification. The 0-0-1-1 (GHQ) method was used for analyzing the GHQ items in this study.

5.2.4.2 PROFILE OF MOOD STATES

The Profile of Mood States (POMS) (McNair *et al.,* 1992) consists of 65 adjective items which require a response of '0' to '4' from the subjects. Seven scores are derived from the scale, 6 of which are factor scores, and the 7th is an index of total mood disturbance. The scale is recommended primarily for the assessment of mood states in psychiatric outpatients. The authors state that it is designed to identify and assess transient, fluctuating affective states and they claim that it 'has proved to be a sensitive measure of the effects of various experimental manipulations upon normal subjects and other nonpsychiatric populations' (1992, p. 1). It was therefore considered an appropriate scale for measuring self-reported mood before and after the subliminal mood suggestion. The 'right-now' phrasing was used, asking subjects to report on their feelings at that present moment (see Figure 5.4).

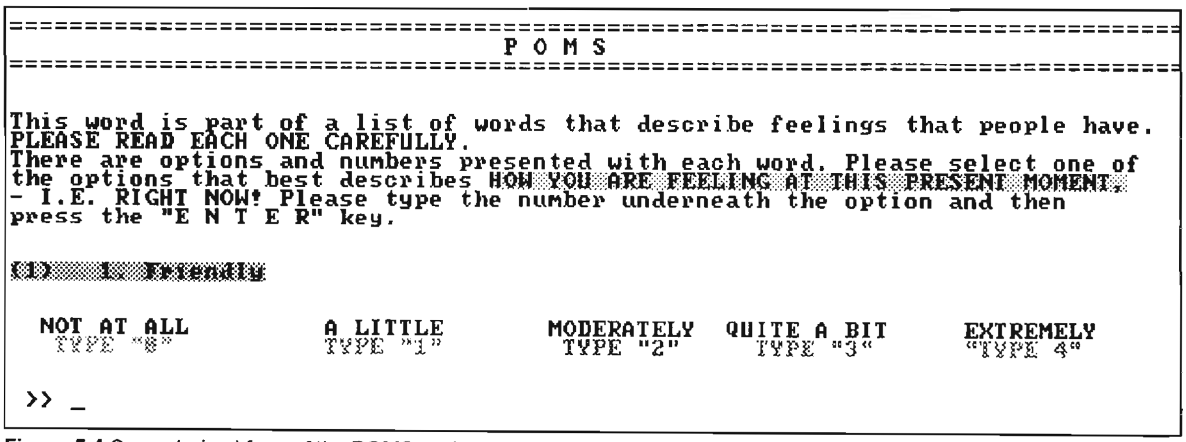


Figure 5.4 Computerised form of the POMS scale.

For convenience sake, and to minimise the experimenter's interference with the subjects, this scale was also administered by computer. Figure 5.4 illustrates the POMS instructions, questions, and rating scale.

The POMS consists of 65 items, and from these, 6 factor scores are computed (scoring system designed by the authors, based on their factor analysis). These are described as follows:

(*T*) Tension-anxiety: heightened musculoskeletal tension, somatic tension, psychomotor agitation and diffuse anxiety.

(*D*) Depression-dejection: depressed mood, feelings of inadequacy, worthlessness, isolation, guilt and futility.

(*A*) Anger-Hostility: anger, and antipathy; both overt and milder feelings of hostility, and more sullen, suspicious aspects are represented.

(*V*) Vigour-activity: mood of high energy, vigorousness, friendliness, and generally positive affect.

(*F*) Fatigue-inertia: weariness, inertia, and low energy.

(*C*) Confusion-bewilderment: bewilderment, 'muddleheadedness', disorganisation.

From these factors, a 'Total Mood Disturbance Score' is computed. The POMS factors listed above and used in the Follow-up study result from an oblique factor solution, and are therefore correlated.

5.3 PROCEDURE

Each subject was tested individually. The procedure started with an introduction to the test laboratory and procedure, and a brief interview. The interview was done to get a brief impression of the subject's mental status (Mental Status Examination: MSE) and to establish rapport. After this the subjects were seated at the computer, and the procedure explained. Since these subjects had participated in the previous experiment (Main Study), they were told that the subliminal messages were different to the ones used in the previous experiment.

The experiment ran in the following sequence, once subjects were seated at the computer.

Screen 1: Recorded 'practical' number.

Screen 2: Recorded subjects' name.

Screen 3: Recorded subjects' gender.

Screen 4: Recorded subjects' home language.

Screen 5: GHQ instructions and prompt (see Figure 5.2).

Screen 6-18: GHQ items 1 to 12.

Screen 19-84: POMS items 1 to 65.

Screen 85: Demonstration instructions informing subjects of the sequence of the experiment: 1). A focussing dot ('☺') would be displayed in the centre of the screen. 2). A phrase would be flashed in that area (in this case at a relatively long exposure of 2 seconds. 3). A mask of random characters would then be displayed.

Screen 86: The message: 'This is what you will see... Wait a moment!' Demonstration.

Screen 87: Subjects were informed that they would be shown 1 phrase 15 times in the same sequence as the demonstration. They were asked to try as hard as they could to see the phrase.

Screen 88: Subjects were asked to type in the phrase that they saw, and if they did not see anything, to type in the first words that came to mind.

Screen 89: The message: 'You will be asked again to do the POMS questions. Please answer according to how you feel at this point in time'.

Screen 90-155 POMS items 1 to 65.

Screen 156: The subject was thanked for her participation, and informed that she would be debriefed.

After the test was completed, the subject was asked if she saw the stimulus or not. The subject was then asked if she had observed any changes in the way she felt. Scores were examined briefly, and each subject was shown the phrase to which she had been exposed. The experiment was explained in detail, including the rationale behind it. Some time was spent discussing the subjects' response to the subliminal phrase, and a brief MSE-type assessment of the subject's affect, and mood was made. Questions regarding the procedure were invited, and the subjects were all asked to contact the experimenter if they experienced any mood change, or unusual emotions after the experiment.

5.4 RESULTS

The results of the various scales used in the experiment are presented and discussed separately. Firstly, the General Health Questionnaire scores will be presented, then the Profile Of Mood States scores and the various statistical procedures are described.

5.4.1 GENERAL HEALTH QUESTIONNAIRE (GHQ)

The mean scores and standard deviations of the GHQ items are presented in Figure 5.5 (see Table 5.1 for a list of the items). The last bar in the graph (*Gscore*) represents the Likert total which is the total score of the 12 items. All items were scored using the GHQ scoring method: 0-0-1-1, see section 5.2.4.1 for details. Goldberg suggests a cutting score of 1 or 2 for the identification of cases and the mean GHQ score for this group was 5.57.

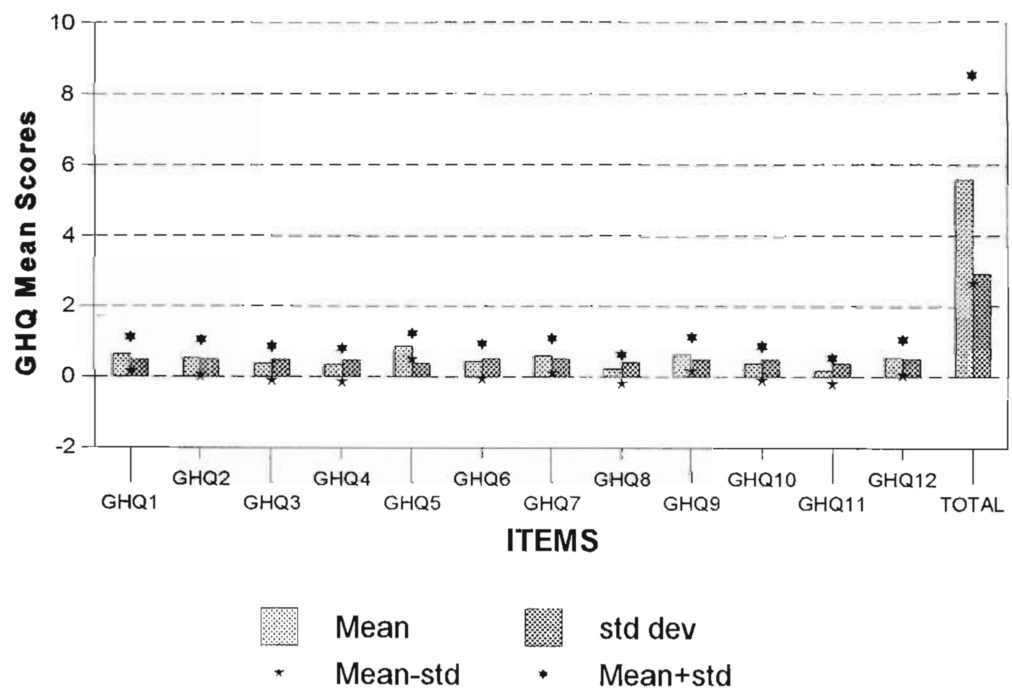


Figure 5.5 GHQ mean and standard deviation scores. Superimposed star icons: item standard deviation ranges: mean minus 1 standard deviation; mean plus 1 standard deviation.

In his local study using both English and Zulu versions of the GHQ, John (1996) recorded a mean score of 3.54 for the English version, and 4.22 for the Zulu version. These scores are substantially higher than those suggested by Goldberg, and on the basis of his research, John suggests that 'South African samples tend to score higher on the GHQ than their western counterparts'. He proposes that the cut-offs used for western samples are too low, rather than concluding that the South African Samples were more distressed. It is possible that the sample was biased, and a proportion of the individuals who volunteered may have been distressed and seeking help.

It is apparent that the mean score of this sample follows a similar trend to that in John's South African sample. Another, or additional reason for the elevated GHQ scores seen in this sample may have been due to fatigue experienced as a result of mid-year examinations. All of the subjects in the sample were either in the process of preparing for, or had written examinations shortly before the experiment, and most commented that they were 'feeling stressed' on this account. On the basis of the scores, and the informal MSE interview, it seemed that some subjects were suffering from an adjustment disorder of mild to moderate severity. Subjects such as these who seemed distressed, were asked to contact the experimenter if the symptoms persisted.

Figure 5.5 shows that the item with the highest mean score was GHQ item 5 (*GHQ5*) ('...felt constantly under strain'). The next highest item was *GHQ7* ('...been able to enjoy your normal day to day activities'), followed closely by *GHQ9* ('...been feeling unhappy and depressed'), *GHQ1* ('...been able to concentrate on whatever you're doing') and *GHQ12* ('...been feeling reasonably happy, all things considered'). All questions were rated in such a way that a score was always in the negative direction, thus a high score *GHQ12* would signify that the subject was **not** feeling reasonably happy, all things considered. The scores ranges (shown by the star icons) within plus or minus one standard deviation of the mean is shown superimposed in Figure 5.5. These show the variability of the scores, and illustrate the range of the majority of the scores (66%) on each item. Note that the variability of *GHQ3* was the highest (SD=1.06). Generally the variability between items was reasonably constant. Since *Gscore* is the total of the 12 sub-scores (GHQ1-12), the variability is naturally higher.

It may be concluded that the GHQ scores reflected a higher than usual degree of distress in the subject group. Generally, average scores suggested that subjects were suffering from stress. The range of most of the *Gscore* totals was well above the cutting score suggested by Goldberg (1 or 2), and the sample mean (5.57) was above that of John's sample (3.54). The comparison is fair, since this sample was comprised of mainly English home language speakers (17 out of 19). It was suggested that the increased scores may have been an artifact of the fact that most subjects were self-selected.

5.4.2 POMS

In this section, the results of the POMS test will be presented as an analysis between groups, and as an analysis of pre/post conditions.

5.4.2.1 GENERAL OBSERVATIONS

Observations of a general nature will be made in this section regarding the POMS factor scores and Total Mood Disturbance Scores. The factors will be referred to as follows:

Tension-anxiety: *T*

Depression-dejection: *D*

Anger-hostility: *A*

Vigour-activity: *V*

Fatigue-inertia: *F*

Confusion-bewilderment: *C*

Total Mood Disturbance: *TMD*

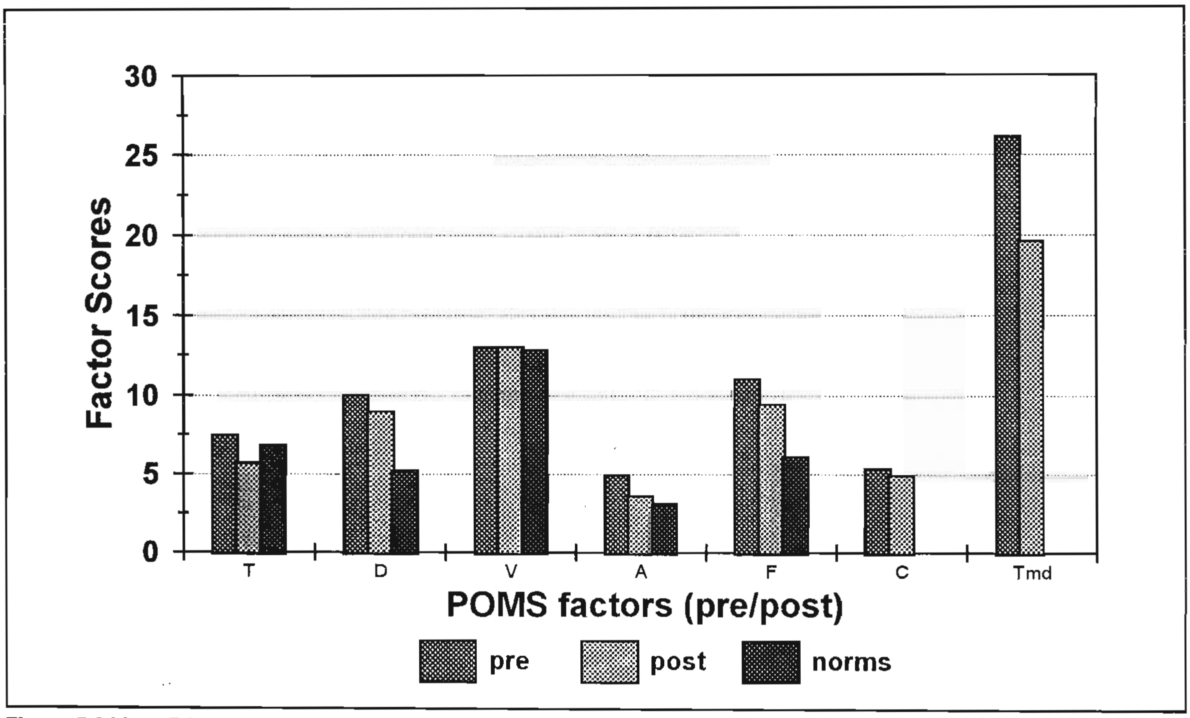


Figure 5.6 Mean POMS factor scores: pre/post exposure and normative scores, all subjects.

The POMS factor scores appear in Figure 5.6. These are the means for all subjects (n=19). The norms shown in Figure. 5.6 are based on the 'right now' form with a sample of 113 college males in the baseline condition. Norms for *C* and *TMD* were not available.

In all factors except *V*, there is a tendency for scores to be lower in the post-exposure condition. Scores on factor *D* are noticeably higher than the published norm (pre=10; post=8.9, norm=5.2). Scores on factor *F* are also higher in this sample than the norm (pre=11; post=9.4; norm=6.1). The scores on factor *T* are comparable to the normative mean, and the scores on factor *V* are almost identical to the published norm.

The pattern of scores (+*D*,+*F*) reinforces the impression gained also from the MSE that generally, the subjects' mood was somewhat dysphoric. When this data is seen together with the GHQ data, it seems clear that the participants were feeling strained, fatigued, experienced some difficulty with concentration and were generally not happy. Much of this is explained by the fact that they had recently been under severe work pressure.

5.4.2.1.1 BASELINE POMS MEASURES (BETWEEN GROUPS)

No significant differences were found on pre-intervention measures between groups. The results of the *t*-tests are shown in Table 5.2. The greatest difference between groups was on factor *F* (Fatigue), although this was not statistically significant. The mean score on this factor for Group 1 was 13.1, and 7.9 for Group 2.

Table 5.2 *t*-tests: pre-exposure, between groups.

POMS Factor	t value	2-tailed prob.
T	0.44	0.67
D	0.1	0.92
V	0.34	0.74
A	0.23	0.82
F	1.5	0.15
C	0.15	0.88
TMD	0.36	0.72

5.4.2.1.2 POST-EXPOSURE POMS MEASURES (BETWEEN GROUPS)

No statistically significant differences were observed between groups in the post-intervention condition, although one trend is worth noting. Subjects in the *sad* condition tended to score lower on the variable *A* ('Anger-hostility') Group 1:

Table 5.3 *t*-tests: post-exposure, between groups.

POMS Factor	t value	2-tailed prob.
T	0.27	0.79
D	0.65	0.53
V	0.19	0.85
A	1.33	0.2
F	0.9	0.38
C	0.35	0.73
TMD	0.31	0.76

mean=2.64; Group 2: mean=5.00.

5.4.2.1.3 CHANGE WITHIN GROUPS

Figure 5.7 illustrates the mean factor scores between conditions and groups. Note the changes in mean scores on factors *T,D,A* and *F* between groups in the pre/post exposure conditions. In Group 1 (*sad* condition) there is a slight decline in the post-exposure condition on these

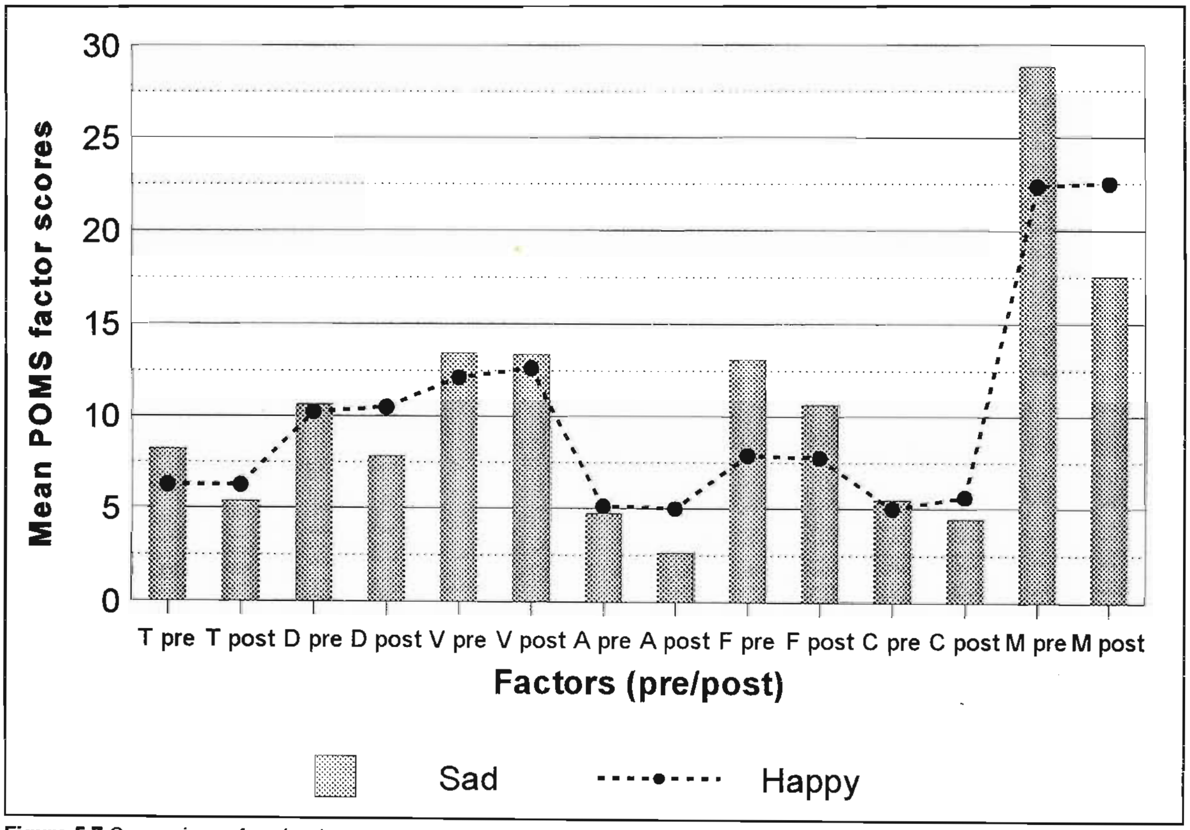


Figure 5.7 Comparison of pre/post-exposure mean scores.

factors (represented by bars in Figure 5.7), whereas in Group 2 (*happy* condition) this pattern is generally absent on all factors (see the dashed line in Figure 5.7). The abbreviations 'M pre' and 'M post' in Figure 5.7, refer to Total Mood Disturbance (*TMD*) pre-test, and post-test respectively. Note that the factor *V* (Vigour) mean did not change between conditions in Group 1, and increased slightly in Group 2.

Table 5.4 *t*-tests: pre/post-test, (Group 1), paired samples.

POMS Factor	t value
T	1.1
D	1.08
V	0.06
A	1.92
F	1.55
C	0.67
TMD	1.21

The significance levels of the *t*-tests (for paired samples) are shown in Figure 5.8 with the critical values for $p<0.05$ of the 2 groups. The critical value of t for Group 1 is 2.228 (df=10), and that for Group 2 is 2.365 (df=7), and these are shown by the lower and upper line respectively in Figure 5.8. Note that none of the tests were significant at the level $p<0.05$. The actual values are shown in Table 5.4. The significance level of the pre/post-exposure difference in factor *A* for the *sad* group is $p=0.086$. This approached statistical significance.

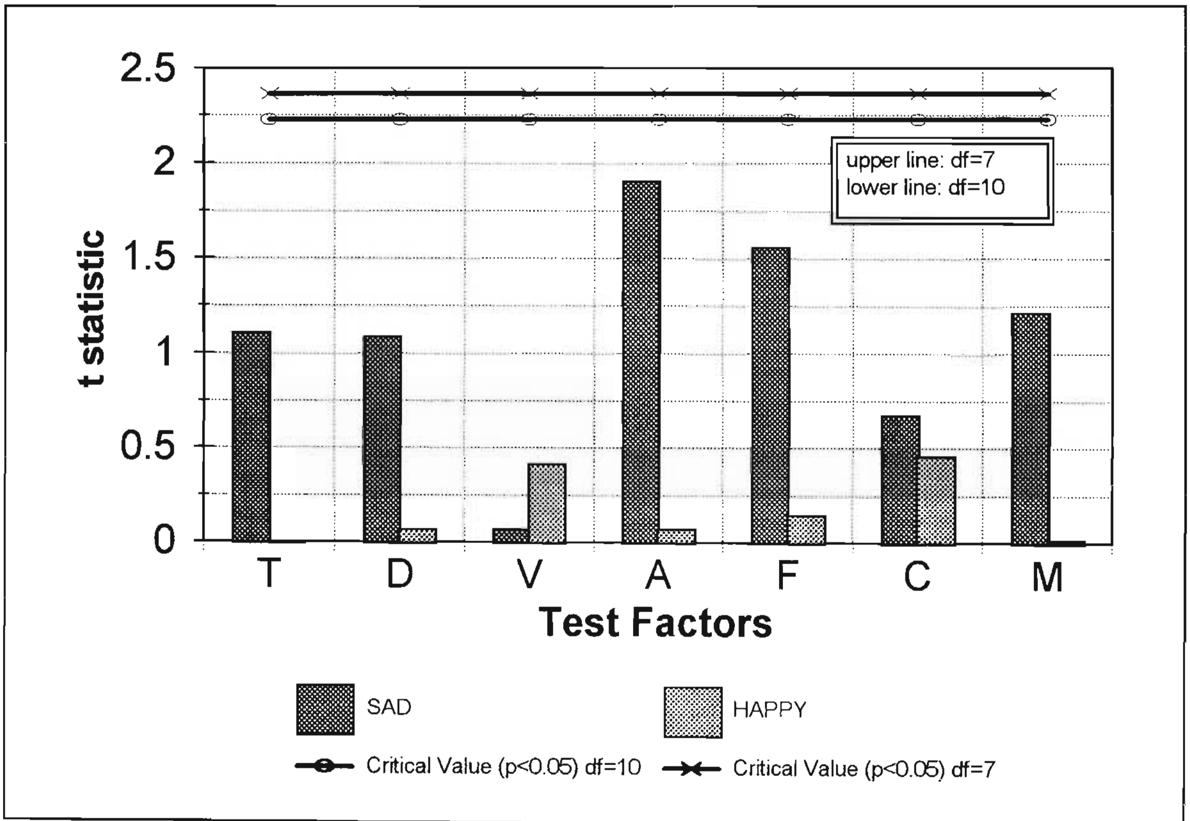


Figure 5.8 Significance levels of pre/post-exposure differences between groups.

It seems fairly clear from the pattern of results, that exposure to the *sad* stimulus was associated with a trend towards lower mood factor scores in the case of the variables *T,D,A,F,C,TMD*. While none of these changes is statistically significant, the fact that there is a pattern of trends in the data is of interest.

5.4.2.1.3.1 THE BOOTSTRAP

In this section, the bootstrap technique will be described briefly, and its usefulness for estimating the reliability of the t statistic in the test data will be discussed.

Bootstrapping is a technique invented by Efron (1977, in Diaconis and Efron 1983, p. 96) which allows for a relaxation of the assumption that data conform to a Gaussian distribution. It is a technique which allows for the exploration of other statistical properties of a sample. Bootstrapping is a resampling method which involves iteration of statistical calculations, using samples drawn from the original sample on a random basis.

According to Efron and Gong (1983), bootstrapping is highly applicable, and requires little in the way of 'modelling, assumptions, or analysis, and can be applied in an automatic way to any situation, no matter how complicated' (p. 36). The major factor constraining its use, is the fact that it is highly intensive with regard to computation, and requires large numbers of arithmetic operations to be carried out. Efron and Gong remark that the bootstrap substitutes theoretical analysis with computational power.

Essentially, bootstrapping involves resampling (with replacement) at random from the original sample a large number of times, and calculating the statistic in question that number of times from each random sample. The object of this is to obtain an estimate of the true value of the statistic in question, and so estimate the true value of the statistic in the population from which the sample was drawn.

In their article, Efron and Gong demonstrate the validity of this method with the estimation of the true value of Pearson's r in a random sample of 15 sets of scores drawn from 82 such sets of data where the true value of r was known. In this case, the true value (based on 82 measures) was 0.761. The bootstrap estimate of the true value of r was done by taking a random sample of 15 sets of scores, and then resampling, on a random basis from this sample, 1000 times, and recalculating r for each bootstrap sample. In this way, 1000 samples were taken at random from the original sample of 15 scores, and r was calculated for each sample. The result of the 1000 bootstrap replications is a frequency distribution of the correlation coefficient r. The bootstrap estimate of r is made from the resulting frequency distribution. One standard deviation either side of the mean is an 'estimate of the average amount by which the observed value of r for a sample differs from the true value of r.' (Diaconis and Efron, 1983, p. 100). For 1000 iterations, the bootstrap estimate of r is estimated as the mean of the bootstrap replications, in which case it would be 0.781.When compared with the **true** value of r (0.761) for the 82 data sets, from which the sample of 15 was drawn, it is a reasonable estimate. Another estimate could be obtained from the standard deviation of the bootstrap whereby there is a 68% probability that the true value of *r* lies within 1 standard deviation of the mean.

It is assumed that the larger the number of bootstrap replications, the more reliable the estimate of the true value of the statistic in question will be. The logic behind the bootstrap procedure, is that the process of random sampling is mimicked within the existing data set. Diaconis and Efron suggest that the bootstrap is the statistical equivalent of the hologram in that the properties of the population from which the sample was drawn are preserved in the sample which is a 'fragment' of that sample. In the same way that a scene can be reconstructed in detail from the light waves that are emitted from a fragment, it is suggested that the properties of the population can be reconstructed from a sample (p. 102).

The sample used in the present study was relatively small, and the estimations of change likely to be less reliable than in a larger sample. For this reason, it was thought that the bootstrap would be an appropriate way of estimating the reliability of the changes associated with *condition*. Specifically, an estimate of the reliability of the *t* statistic, means and standard deviations were desired (See Appendices E,F,G).

A program was written in *Pascal* to calculate bootstrap estimates of the *t* statistic for the change scores of each group, and the means and standard deviations of both groups for each factor in the pre/post-test conditions. These will be presented in the following section.

5.4.2.1.3.1.1 BOOTSTRAP ESTIMATION: MEAN AND STANDARD DEVIATION

Table 5.5 shows the sample and bootstrap estimates of the pre/post-exposure scores of Group 1. The bootstrap estimates of these statistics are means, based on 10^6 iterations. Note that the means in the '*BOOT*' section of the tables are the mean of 10^6 bootstrap samples. The bootstrap estimates of the standard deviations are the means of 10^6 bootstrap standard deviations. It can be seen in Table 5.5 that the bootstrap estimations of the standard deviation are generally lower than the sample statistics. These differences are illustrated in Figure 5.9.

Table 5.5 Sample and bootstrap estimates (mean based on 10^6 iterations) of mean and standard deviation for Group 1 pre/post.

GROUP 1 *SAMPLE*	PRE		POST		GROUP 1 *BOOT (10^6)*	PRE		POST	
	Mean	Std.	Mean	Std.		Mean	Std	Mean	Std.
T	8.18	11.15	5.36	6.92		8.18	10.52	5.36	6.3
D	10.63	9.82	7.81	8.45		10.63	9.14	7.81	7.86
A	4.73	3.69	2.63	3.35		4.73	3.49	2.63	3.04
V	13.45	8.78	13.36	8.51		13.45	8.29	13.36	8.02
F	13.09	9.06	10.63	7.83		13.09	8.53	10.63	7.3
C	5.45	6.64	4.45	6.59		5.45	6.3	4.45	5.96
TMD	28.81	45.51	17.54	33.79		28.81	42.77	17.55	31.03

In Figure 5.9, the notation is as follows:
Std(s)1 : sample, pre-test
Std(b)1: bootstrap pre-test
Std(s)2: sample, post-test
Std(b)2: bootstrap, post-test.

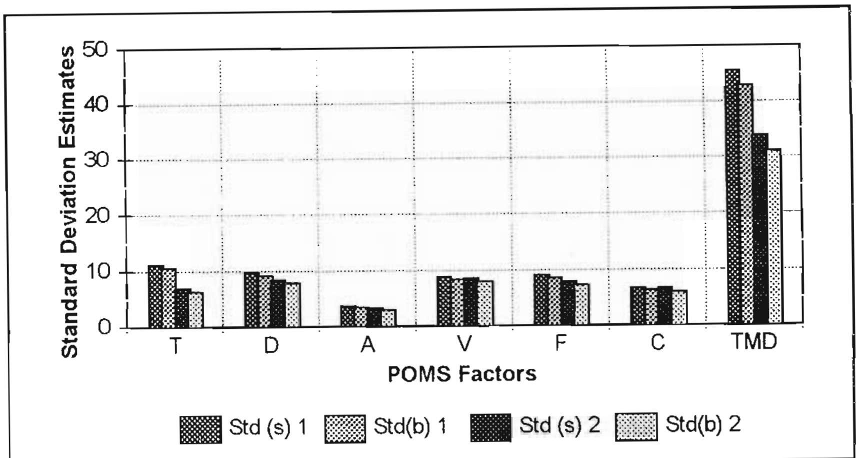


Figure 5.9 Sample and bootstrap estimates of standard deviation pre/post-exposure.

Table 5.6 Differences between sample and bootstrap estimates of standard deviation (%).

Factor	Pre	Post
T	5.65	8.96
D	6.92	6.98
A	5.42	9.25
V	5.58	5.76
F	5.85	6.77
C	5.12	9.56
TMD	6.02	8.17

In Table 5.6, the differences between the samples and bootstrap estimates of standard deviation are expressed as a percentage difference. All values represent the percentage by which the bootstrap estimate was less than the sample estimate. (Note that in bootstrapping, the SD is calculated separately for each sample so that the lower values of the bootstrapped estimate do not result from the cancellation of errors which occur when many items are amalgamated into a single test statistic). The greatest difference in the pre-test estimate is seen in the variable *D* which was 6.92% less than the sample estimate. The smallest difference is seen in the variable *C* (5.12%). The greatest difference in the post-test estimate is seen in the variable *C* (9.56%), and the smallest difference is seen in the variable *V* (5.76%). It is interesting to note that the standard deviation of the variable *V* generally showed the smallest changes between pre/post-test conditions (5.58% vs. 5.76%). It can be concluded that generally the sample standard deviation estimates are likely to be higher than the true values.

Some of the bootstrap frequency distributions are presented for brief comment. These distributions were plotted after the data was smoothed (exponential method) and are the result of 5000 iterations. Figure 5.9.1 shows the frequency distribution of the pre-test mean of factor *V* for Group 1 and similarly in Figure 5.9.2, the standard deviation.

The distribution of the mean in Figure. 5.9.1 is close to normal (kurtosis = -0.2; skewness = -0.1) and the mean, median and mode are close to each other: 13.43, 13.45, 14.36 respectively. The sample mean was 13.45, and the bootstrap estimate based on 10^6 iterations was 13.45. This suggests little variability in the estimation of the mean.

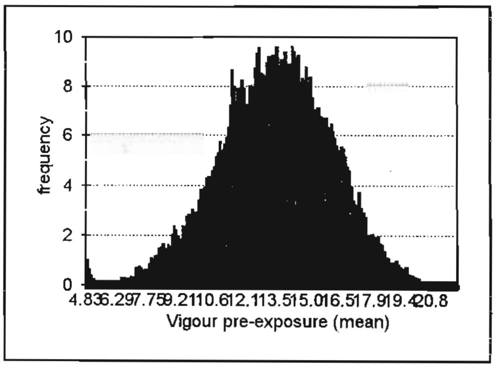


Figure 5.9.1 Frequency distribution of the mean for factor *V* (pre-test).

The standard deviation distribution shown in Figure. 5.9.2 shows a negative skew, and is slightly more flat than a normal curve (kurtosis = 0.14; skewness = -0.42). The 95% confidence level indicates that the mean value of the standard deviation lies between 8.25 and 8.31.

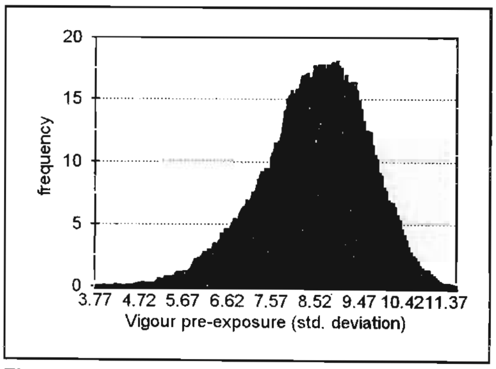


Figure 5.9.2 Frequency distribution of the standard deviation for factor *V*.

The post-test frequency plot of the mean is displayed in Figure 5.9.3. The properties of the post-exposure frequency plot show little change between the pre- and post-exposure *condition* (kurtosis = -0.08; skewness = -0.1), and other measures of central tendency and variability remain almost unchanged. Figure 5.9.1 and 5.9.3 compared the distributions of the mean for the pre/post-test conditions of the

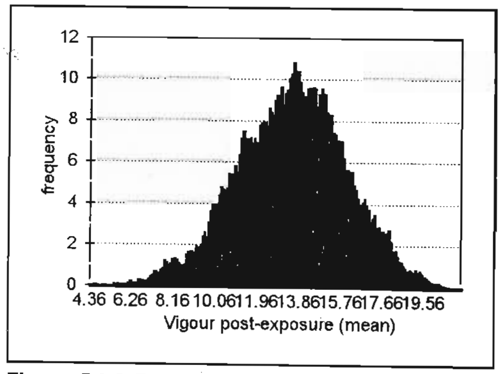


Figure 5.9.3 Frequency distribution of the mean for factor *V* (post-test).

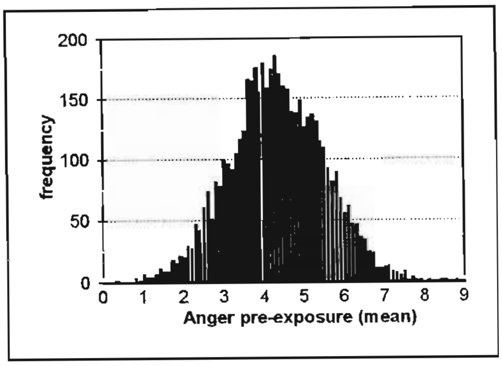


Figure 5.9.4 Frequency distribution of the mean for factor *A* (pre-test).

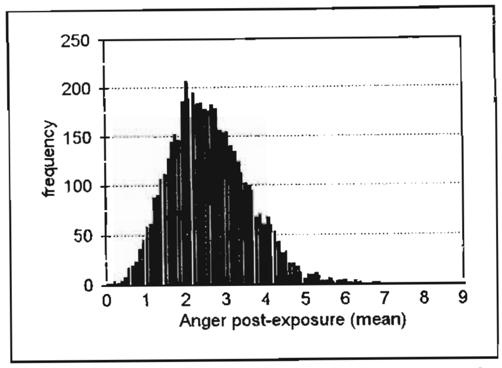


Figure 5.9.5 Frequency distribution of the mean for factor *A* (post-test).

variable *V* (5000 iterations). This comparison was made because the variable showed the least amount of change in Group 1 (see Figure 5.8). The variable which showed the highest degree of change was *A* (Anger-hostility). The mean scores decreased from 4.73 to 2.63 in Group 1, and was largely unchanged in Group 2 (see Figure 5.7). The frequency plots of this variable appear in Figures 5.9.4 and 5.9.5 (pre/post-test).

The frequency distribution before and after the subliminal intervention shows some differences. In the pre-exposure condition, the distribution is close to normal (mean = 4.74; median = 4.72; mode = 4.72; kurtosis = -0.08; skewness = 0.02), and in the post-exposure condition, a marked positive skew is evident (mean = 2.64; median = 2.54; mode = 2.09; kurtosis = 0.31; skewness = 0.49).

In the post-exposure condition, a relatively large number of bootstrap replications fell below the mean. This indicates that there were a number of subjects who scored considerably lower on *A* after the intervention.

The bootstrap procedure was intended to give an estimate of the true value of the mean from the population from which this sample was drawn. While the bootstrap estimate of the mean did not vary significantly from the sample value in any of the variables, the change in distribution between the pre/post condition suggests that the subliminal intervention is reliably associated with a positive skew in the data. Admittedly this analysis was based on only 5000 iterations, since larger data files became unmanageable for the analysis of a frequency distribution. However, the fact that the estimates made with a much larger number of iterations (10^6) were comparable, suggests that the frequency distribution generated was reliable.

5.4.2.1.3.1.2 BOOTSTRAP ESTIMATION OF *t*

Table 5.7 shows the sample and bootstrap estimation (mean) of the *t* statistic for pre/post conditions (paired). This data is graphed in Figure 5.9.6. The lower and upper line in the top part of the graph represent the critical values of *t* for 7 and 10 df respectively, $p<0.05$. The number of iterations varied between 2000 and $2x10^6$. The reason for the difference in the number of iterations is that with some data sets, the bootstrapping program tended to terminate after a short number of iterations with a run-time error (division by zero). The algorithm calculating the *t* statistic was correct, and this error occurred more often with some data sets, than with others. It seemed that the error occurred when a possible, but unusual bootstrap sample was made which consisted of zeros and caused a divide-by-zero error.

Table 5.7 Sample and bootstrap estimates of *t* (paired samples).

	GROUP 1		GROUP 2	
	SAMPLE	*BOOTSTRAP*	*SAMPLE*	*BOOTSTRAP*
T	**1.105**	**1.066*******	0.000	0.388***
D	1.084	1.234****	0.064	0.109***
A	1.902	2.157****	*0.068*	*0.072****
V	0.065	0.081****	*0.413*	*0.418****
F	*1.553*	*1.612****	**0.143**	**0.076****
C	0.674	0.743*****	**0.458**	**0.112***
TMD	*1.209*	*1.261******	*0.012*	*0.011****

*iterations=$2x10^3$ **iterations=$1x10^4$ ***iterations: from $2x10^4$ to $5x10^4$
****iterations=$1x10^6$ *****iterations=$2x10^6$

The bootstrap estimates of *t* were mostly higher than the sample estimates, but this was not invariably the case. The scores which show little change are italicised in Table 5.7, those showing relatively large negative changes appear in bold, and those showing relatively large positive changes are underlined. The bootstrap estimates where the number of iterations was low are probably less reliable (see the discussion which follows below). This data is perhaps more comprehensible when seen in graph form. Figure 5.9.6 displays the same data as that in Table 5.7. The lower line in the figure represents the critical value of *t* for $p<0.05$, df = 10 (this applies to Group 1), and the upper line represents the critical value of *t* for p<0.05, df = 7 (applicable to Group 2). The level of significance for *t* with the variable *A* for the sample estimate is $p=0.086$, and that for the bootstrap estimate is $p=0.0585$. This brings the change close to being statistically significant.

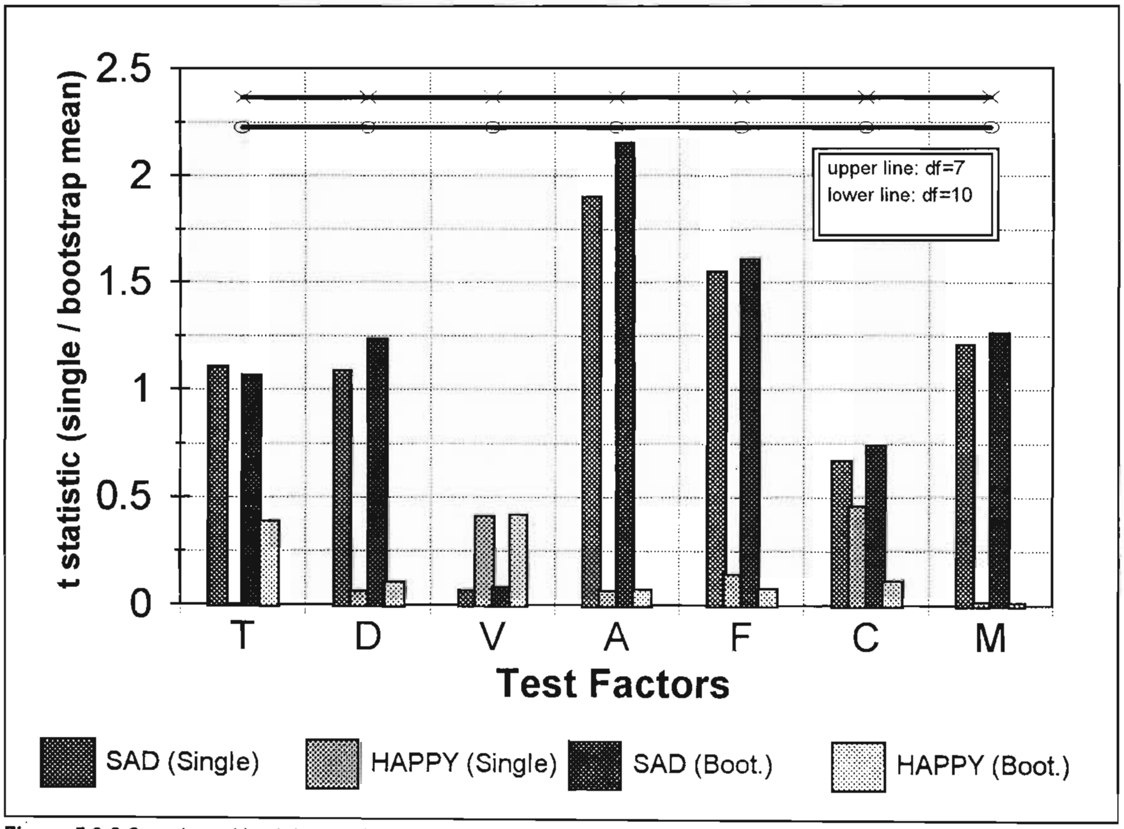


Figure 5.9.6 Sample and bootstrap estimates of *t* (paired samples).

The bootstrap estimate of *t* varies in the following ways:

1) less than the sample estimate

2) approximately equal to the sample estimate

3) greater than the sample estimate

This shows that the bootstrap estimate of *t* is not a function of the number of iterations. The bootstrap estimates of *t* for factors *F* and *C* in Group 2 were lower than the sample values, but number of iterations was also low. It is not likely that the estimate was low simply because of the small number of iterations. In the case of factor *C* a further 5 runs (2000 iterations each) yielded estimates that were comparable (0.125; 0.138; 0.155; 0.087; 0.163). The mean of these estimates is 0.133. In the case of factor *F*, 2 further runs (10000 iterations each) were done (0.064; 0.072), both of which are reasonably close.

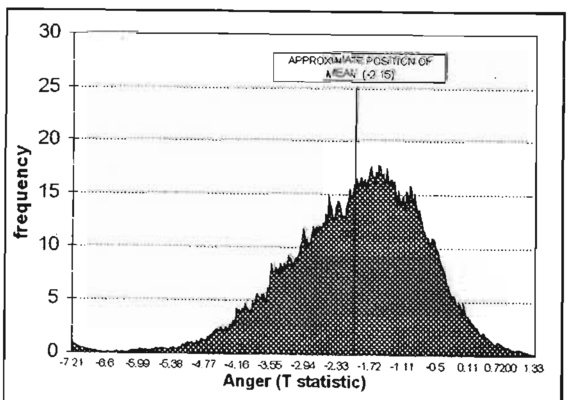


Figure 5.9.7 Frequency distribution of *t* statistic (group 1).

Figure 5.9.7 shows the frequency plot of the bootstrap estimation of t (5000 iterations) for group 1. This estimate (2.15) agrees well with the previous one which was based on 1×10^6 iterations (2.157). Whether the t statistic is negative or positive is arbitrary, and the absolute value is used. The distribution in Figure 5.9.7 shows a negative skew (-0.4) which signifies that a number bootstrap replications were done which resulted in high values (on the left side of the graph). This caused an increase in the value of the mean. The conclusion that can be drawn from this is that the true value of t is likely to be higher than the sample value, and is probably close to the $p<0.05$ level.

The frequency distribution for Group 2 (*A*) is shown in Figure 5.9.8 (5000 iterations). This distribution has a positive skew (skewness = 0.24). While the difference in scale is somewhat misleading, it can be seen that the distribution of the t statistic differs from that of group 1. Group 2 has a mean of 0.06 and a median of 0.07, vs. 2.15 and 2.04 in Group 1. The bootstrap replications suggest that the true value of t is close to zero for Group 2.

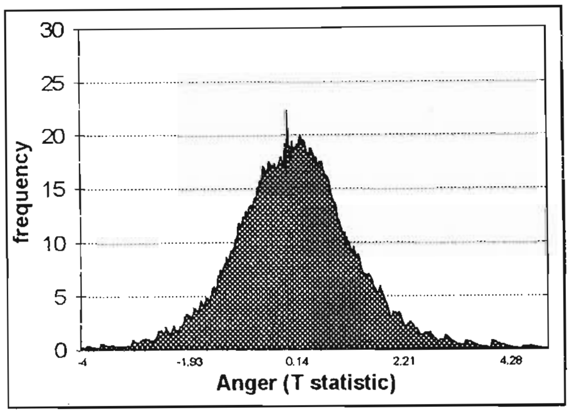


Figure 5.9.8 Frequency distribution of t statistic (group 2).

There is a single result (*A*) in the experiment which approached significance, and this was in Group 1. It may be seen from Figure. 5.8 that the means of the factors in Group 2 did not vary much between the pre/post condition, but the means of Group 1 did, although the amount by which they varied was not statistically significant. The bootstrap estimations of t suggested that the true values of t were higher for factors *D,A,F,C* and *TMD*. Although only one measure approaches significance, the pattern of differences between groups is interesting and will be commented on further.

5.4.2.2 PREDICTION ANALYSIS

The prediction analysis procedure developed by Hildebrand *et al.* (1977) will be described in this section, and applied to the analysis of the data pattern found in this study.

Hildebrand *et al.* (1977) developed this procedure as a way of analysing patterns in ordinal, non-parametric data. Specific predictions are made concerning the state of variables in various categories, and the success of the prediction ($\wp$) is measured by the magnitude of the delta (∇) statistic. The ∇ statistic ranges from 0 (no prediction success) to 1 (highest prediction success).

An assumption made by this method is that the variables are independent of each other, and it must be noted from the outset that this was not the case in the factors derived in the POMS. The POMS factors resulted from an oblique factor solution, and these were therefore correlated with one another. This complicates any conclusions that can be drawn from the analysis. The prediction analysis is therefore offered as illustrating a potentially useful method of analysing data patterns such as the one found in the Follow-up Study.

A second consideration in the use of this technique is that it was applied as a *post hoc* method of analysis. In terms of a scientific approach this is not ideal, but its use was considered to be justified in this thesis since it is an exploratory study which has generated a number of further research hypotheses.

The analysis was done by comparing the pre/post-exposure scores on the 6 POMS factors. This was done for Group 1 (*sad* Group) only, since it was seen that positively valenced ('happy') stimuli were not likely to evoke changes. Group 2 (*happy*) functioned more or less as a control group in terms of responses, so it was not sensible to make a *post hoc* prediction of no change for this group. The prediction tested by the analysis was that scores would be less in the post-exposure condition for Group 1.

The intervals for judging score categories were decided as follows:

LOWER: a negative change in the factor mean between pre/post conditions that was greater than 0.5.

SAME: the mean post-exposure factor score was within 0.5 of the pre-exposure score.

HIGHER: a positive change in the factor mean between pre/post conditions that was greater than 0.5.

The resulting contingency table appears in Table 5.8. Two possible predictions are shown by shading in the relevant cells and are expressed:

$\wp_1$: SAD ⇒ LOWER (darker shading)

$\wp_2$: HAPPY ⇒ SAME (lighter shading)

The second prediction, $\wp_2$ is given for the purpose of illustration only, and was not seriously entertained.

Table 5.8 Post-exposure score categories by group.

	SAD	HAPPY	
LOWER	5	0	5
SAME	1	4	5
HIGHER	0	2	2
	6	6	12

$\wp_1$ predicts that factor scores in the 'sad' group will be concentrated in the upper left hand cell ('LOWER'). Essentially, they are predicted to be lower.

$\wp_2$ predicts that factor scores in the 'happy' group will be concentrated in the middle cell of the second column labelled ('SAME').

The statistics calculated for these predictions are shown in Table 5.9. Note that the prediction success of $\wp_1$ is good (∇=0.71), and that of $\wp_2$ is mediocre (∇=0.43).

Table 5.9 Prediction statistics.

observed errors	1
expected errors	3.5
delta (∇)	0.71
observed errors	2
expected errors	3.5
delta (∇)	0.43

Had the independence assumptions of the prediction analysis been met, reasonably strong evidence would be seen for the prediction that scores would be lower in the 'sad' condition, and hence that a pattern of changes in the data may actually be demonstrated. In other words, there was a good fit in the data for this prediction of pattern. As it stands, no definite conclusion can be drawn from the test, and it merely **illustrates** the hypothesis suggested earlier, that there is a pattern of differences associated with the 2 subliminal exposure conditions.

5.5 CONCLUSION

No clear findings can be reported from this experiment, but the existence of a number of trends strongly suggests a pattern. The following trends were considered to be of interest:

1. There was little difference between the means of two groups on the pre-exposure POMS factor *A* (Anger) (Group 1: 4.73; Group 2: 5.1; $p<0.82$), but a larger difference in the post-exposure condition (Group 1: 2.6; Group 2: 5.0, $p<0.2$). Thus, the mean score in Group 1 declined, while that in Group 2 remained constant. Thus, two trends are observable in this variable: the between-groups change ($p = 0.2$, and the within-groups change ($p = 0.08$).
2. After subliminal exposure, scores on factors *T, D, A, F* showed noticeable trends towards lower values in Group 1, but no such trends in Group 2. The bootstrap estimations show that it is likely that the true values of the relevant *t*-test statistics were higher than the sample statistics, hence it is arguable that the magnitude of the changes associated with the *sad* subliminal exposure was underestimated in this experiment.
3. Following on from the argument made in point 2 above, bootstrapping suggested a value of *t* for the change (pre/post) in Group 1 which is close to significance ($p = 0.058$) on the variable *A*. In Group 2, bootstrapping suggested that the true values of the *t* statistic for two variables *F* and *C* were lower than the sample values. On the other hand, bootstrapping suggested that the true values of *t* (pre/post) were underestimated for *T* and *D*. It is not known what the direction of these changes would be. However, it was generally the case that bootstrap estimates of change statistics were smaller in Group 2 than in Group 1.

The question posed at the beginning of this chapter was 'Does some clear change in mood occur through subliminal suggestion, and if so, can it be reported directly, or would it have to be inferred indirectly through some pattern in the data?' The answer which is suggested by the data is that a negative subliminal mood stimulus (Group 1) appears to be associated with the tendency to report improvements in mood. Trends in the data suggested that subjects exposed to such a stimulus reported improvements in the following mood factors (in order of significance):

Anger-hostility
Fatigue-inertia
Depression-dejection
Tension-anxiety
Confusion-bewilderment

This is an unexpected reaction to the subliminal mood stimulus, and it is interesting that a negative stimulus appeared to evoke positive changes in self-reported mood. Acceptance of the null hypothesis is justified in the case of the group exposed to a positive mood stimulus (Group 2). No single significant change was evident in this group, and no pattern of trends was observed. The only slight change seen was a small improvement in the factor *V (Vigour-activity)*.

The trends obtained in this study provide a basis on which to speculate that a paradoxical improvement in mood occurred after exposure to a noxious (sad) stimulus. Such a change in mood was reported even though subjects were not able to record the stimulus phrase to which they had been exposed.

It is interesting that there was no change evident in the POMS factor *Vigour-activity* in Group 1. This factor was unique in that it represents a 'positive affect factor'. In other words, the trends suggested a reduction on negative (tending towards a negative or pathological mood) mood factors, but no accompanying improvement on a positive factor.

It must be pointed out once more that no single result was statistically significant at $p<0.05$, although one change approached this level very closely. From a strict statistical point of view, this study shows null findings. On the other hand, it is argued that since a coherent pattern of differences exists in the data, these are likely to reflect the effects of the subliminal mood suggestion, and not mere randomness. It must be acknowledged that a further study with more subjects would have been preferable to the amount of analysis undertaken in this chapter, but there were severe time constraints, and recruiting another, larger group of subjects would have proved costly.

6. A REFLECTION ON EXPLORATORY DATA ANALYSIS

6.1 INTRODUCTION

In this thesis, a number of statistical methods have been employed in the analysis of the data, and, it has to be acknowledged that a simple confirmatory model has not been followed. It may seem that license has been taken in the use of multiple tests of significance in both the Main Study and Follow-up study, and there are reasons why this practice may be frowned upon. I would like to make the point in this chapter however, that there is some legitimacy in the practice of exploring the data thoroughly, and this practice has indeed been turned into a distinct approach, along with various associated techniques. Tukey, for example is a proponent of the method of Exploratory Data Analysis, and has developed various techniques for exploring and describing data.

6.2 EXPLORATORY DATA ANALYSIS

This thesis is offered as a preliminary study of subliminal mood priming, and in the course of the research, I have proceeded from a position of almost complete ignorance on the subject, to the point where some clear findings from the literature have been established in my mind. The data from the initial experiment appeared to be exceedingly complex, and after the efforts which were made in getting it seemed to deserve more than a cursory glance and a few hypothesis tests. Coming to grips with the data and the information it contains has taken a great deal of effort, and I would like to apologise to the reader for the complexity of the analysis presented. I accept the criticism that 'data mining', or 'data dredging' (Tukey, 1991, p. 103) was done in that multiple tests of significance were used - especially in the item analysis where a large number of Chi-square tests were done, but would like to suggest that a reasonably coherent pattern of findings have emerged which tend to refute possible accusations that they may be due to chance.

On reflection, it may seem that the claims in this thesis were worded a little too strongly, and suggest a certainty which is not warranted, and perhaps the case was made a little defensively, that subliminal priming effects existed. This may have been in some cases, where significance tests were used, and the rather deceptive language of 'certainty' which accompanies significance tests where $p<0.05$ was used.

I would like to try and correct the perception that may have unintentionally been given, that this study produced cast iron evidence for subliminal priming effects. The claims made, are all of a tentative nature, and the language of certainty associated with the significance test may be (especially in this case) largely illusory. Positive results of individual tests of significance, especially where they are accompanied by other tests of significance, do not allow clear conclusions to be drawn. As Ableson remarks, 'random patterns will seem to contain something systematic when scrutinised in many particular ways' (1995, p. 70). It is possible to err on the conservative side however. As Abelson puts it, 'If you look at enough boulders, there is bound to be one that looks like a sculpted human face', but if overly strict criteria for what is to be recognised as a human face are applied, one is likely to 'miss the whole show on Easter Island' (*ibid.*).

It is suggested that a reasonably systematic pattern of significant, or near significant results is less likely to reflect randomness. The pattern of results found in this series of experiments may simply be due to chance - this explanation cannot be ruled out completely. Tukey remarked that 'Every statistician has the obligation to admit that each particular set of data could have come about randomly - given the oddest states of nature' (1969, p. 84). This is not impossible in the present case. The fact that there are some apparent similarities between the results of these experiments and those of other researchers is encouraging, however. For example, the finding in the Main Study that the effect size was positively correlated with the sadness ratings of the items, and negatively correlated witht the happiness ratings, came as an interesting surprise. In the subsequent search for related literature, the series of studies termed the *Preattentive Bias Studies* came to light, and offered a precedent for the finding of a subliminal effect linked to a preattentive bias for negative information.

6.2.1 TUKEY'S APPROACH

In an address at Princeton University, Tukey (1969) contrasted the views of statistics as being either a means of detective work, or sanctification. This was a way of contrasting exploratory data analysis with confirmatory data analysis. Increasingly, there has been a move in the social sciences, away from simple hypothesis testing in the hypothetico-deductive approach prevalent in the forties and early fifties (*ibid.*, p. 90). This has often been held up as the ideal scientific approach, and is characterised by the setting up and testing of an experimental hypothesis deduced from some principle. Statistical tests are used simply to test this experimental hypothesis against a predetermined level of chance ($p<0.05$), and the hypothesis is accepted if the probability of it being due to chance factors is less than this percentage.

In the view of Tukey, and other authors (eg. Cohen, 1994), this method of hypothesis testing is limiting, and hypotheses tested successfully in this manner are not thereby sanctified. Cohen insists that the 0.05 level of significance is not sacred, and refers to Bakan's remark that 'a great deal of mischief has been associated with the test of significance...' (in Cohen, 1994, p. 997).

Tukey emphasised the need for exploration of data, and suggested that the statistician adopt the role of a detective, instead of trying to be a high priest (*ibid.*). He suggested that data be explored before it is analysed, even to the extent of saying that we need to examine it to find out what it *seems* to be saying: 'We want to know what the data *seem* to say, whether or not data mean what they seem - *a fortiori* whether or not we can *prove* that they mean it' (*ibid.*).

Stressing the uncertainty of the process of learning, Tukey insists that 'empirical knowledge is always fuzzy'. He suggested that an essential aspect of 'the information revolution' is 'learning to live with fuzziness' (1991, p. 101). The most dangerous aspect of simply accepting the null hypothesis, he asserts, 'is the giving up of explicit uncertainty' (*ibid.*). He suggests that mathematics as a discipline may be at odds with the world to the extent that its depictions are 'black and white' in terms of truth, whereas our knowledge about the world is not.

The null hypothesis significance test gives an illusory sense of certainty about hypotheses, and according to Cohen (1994), 'it does not tell us what we want to know' but gives the illusion that it is telling us what we want to know. (p. 997). In the case where a null hypothesis is accepted, there is no information available on the actual **truth** of this hypothesis.

In an early paper, Tukey (1962) suggested that three essential constituents of science are:

1. Intellectual content.

2. Organisation into an understandable form.
3. Reliance upon the test of experience as the ultimate standard of validity (p. 5).

He suggests that data analysis, and statistic should take on the characteristics of a science, rather than that of pure mathematics in the following respects:

1. Data analysis must seek for scope and usefullness rather than security.
2. Data analysis must be willing to err moderately often in order that inadequate evidence shall more often suggest the right answer.
3. Data analysis must use mathematical argument and mathematical results as bases for judgement rather than as bases for proof or stamps of validity (p. 6).

He thus sets aside statistics as a way of making authoritative judgements, and emphasises its use as an exploratory tool, and hands the question of judgement back to the observer who is guided by statistical method in his/her own judgements. In fact, Tukey lays a heavy burden of judgement on the observer. According to Tukey, the judgements an observer makes are conditioned by his/her own experience of the subject in question, the knowledge of how various data analysis techniques have been previously applied, and on the body of theory on which the various techniques is based (from *ibid.* p. 9).

6.3 CONCLUSION

Tukey de-emphasises the role of statistics as a means of sanctifying conclusions, and suggests that statistical methods be used flexibly for exploring, describing and understanding data. He suggests that many possible views or pictures may be possible from a given set of data, and argues that this reflects the fuzziness of the world. He insists that the search for certainty through single statistical tests is illusory, and reiterates the point made by Fisher, that 'Repetition is the basis for judging variability and significance and confidence. Repetition of results, each significant, is the basis, according to Fisher, of scientific truth' (1969, p. 85).

In this thesis, I have therefore taken the view that statistics is a useful exploratory tool, and not an authoritative touchstone. Inevitably, much of the theorising has been of a *post hoc* nature, suggested by the rather vigorous exploration of the data. I offer the various results in a tentative way as one possible interpretation of the data, and as a basis for future experimentation. I suggest also that the extensive data analysis and use of statistics was done in the spirit of Tukey's approach, and was justified as a method of preliminary investigation.

7. DISCUSSION AND CONCLUSION

7.1. INTRODUCTION

In previous chapters the burden of the argument has been that the results of the research are not random in the statistical sense. In this chapter, an attempt will be made to show that they are not random in the theoretical sense, and that they can be given a meaningful interpretation. Obviously the pattern offered will reflect the author's philosophical and theoretical biases, and also more than one interpretation could be given to the findings. The interpretation offered in the present chapter is necessarily sketchy and preliminary.

This section will briefly describe the results of the various experiments, and briefly compare them to the findings of other research. The subject of affective arousal will be introduced as a helpful theoretical tool, and theoretical models of mood will be briefly presented and discussed with particular regard to the findings of the Follow-up study. The limitations of this study are mentioned, and suggestions are made for future research.

7.2. SUMMARY OF FINDINGS

This section will present the major findings of the 3 experiments in summary form, and the various hypotheses, where applicable, will be reviewed in the light of the experimental conclusions.

7.2.1 PILOT STUDY

The Pilot Study was designed to test the potential of two types of masking (masking by light, masking by visual noise) for use in subliminal stimulation. To begin with, there was reason to think that a more central type of masking occurred with the masking by visual noise technique. While this could not be verified in the Pilot Study, the masking by light procedure was found to be a more efficient method of masking to prevent awareness.

In the Pilot Study, it was speculated that free association responses had a semantic relationship to the subliminal stimulus. It is interesting that Marcel (1983) also remarks on this phenomenon. In an experiment, Marcel conducted an investigation of reading in children and adults. In this experiment, single words were briefly exposed to the subject, followed by a pattern mask, and the subjects' task was to report whatever words or letters they were able to recall. Marcel remarks that a 'small, but significant proportion of erroneous word responses, while showing little graphic or phonological relation to the stimulus, bore a striking semantic relationship to it. Thus *green* led to responses such as "blue" and "yellow", *queen* to "king", *apple* to "orange", *light* to "dark", *happy* to "joy", *clock* to "time", *chair* to "table" (p. 201). Marcel concluded that unless these responses occurred purely by chance, subjects seemed to be demonstrating knowledge of the stimulus at a 'lexical or semantic level' (*ibid.*). This link is difficult to demonstrate conclusively, but is a hint of the finding that semantic processing may occur in the absence of awareness.

The Pilot Study established that no subjects were able to recognise the test phrase at exposures of less than or equal to (<=) 12.9 ms. Interestingly, single words were recalled by subjects at the 12.9 ms ('she') and <=9.5 ms ('the') level, although subjects were unable to recognise the phrases. It was thus established with a reasonable degree of certainty that subjects were unable to detect the stimulus phrases. On the basis that they were unable to recognise targets at a level greater than that of chance, it could be claimed that this corresponds with the objective threshold. A small sample was tested in this experiment however, so caution is advocated. What is clear however, is that exposures were made below the subjective threshold of awareness.

7.2.2. MAIN STUDY

This experiment was done as an alternative to the research of Halberstadt *et al.* (1995) to see if *subliminal* mood priming was possible. Halberstadt *et al.* showed that the spelling of ambiguous words (homophones) could be affected by a negative mood induction. They found that a 'sad' mood induction was associated with the tendency of subjects to spell the negative meaning of the homophones, but no such priming tendency was found for subjects given the positive mood induction. They concluded that emotional context was implicated in 'low-level cognitive processes' (p. 281) in that emotion-congruent meanings were primed by the mood induction. Halberstadt *et al.* were not able to account for the lack of a positive mood priming effect whereby it was expected that a happy mood would be associated with a tendency to spell 'happy' meanings of words. This research extends that of Halberstadt *et al.* in that the mood priming stimuli were presented below the threshold for conscious identification.

Two basic questions are raised by the research in the Main Study. These are set out as follows:

1. Were subjects unaware of the stimulus?
2. Did any priming effect occur, and if so how was this manifested?

These questions will both be addressed.

7.2.2.1 STIMULUS UNAWARENESS

It is interesting that only one word was correctly identified in the recall test: the word 'happy'. Five subjects identified this word, four of whom were exposed to the 'happy' stimulus. It is curious that one subject gave this word after exposure to the 'sad' stimulus. This may have been a chance event.

The fact that none of the words from the 'sad' stimulus were recognised may be, as Dixon (1991) suggests, that different words have different sensitivity thresholds. Dixon believed that an elevated threshold was related to an underlying emotional complex. This was also suggested by Bengtsson who asserted that when the perceptual threshold for an emotionally loaded word is raised compared to a more neutral stimulus, it is evidence of a defensive operation (1991, p. 38). It seems plausible that different words have different recognition thresholds, and that this may be related to their emotional loading. This implies that the word 'happy' had a lower recognition threshold than the other words.

This finding is interesting since it suggests that the subjects in this study were, for the most part, unaware of the stimulus. No evidence exists that subjects were aware of the negative stimulus, and only 4 subjects were aware of one of the words from the positive stimulus. This finding might be similar to those of Dixon (1991), and Bengtsson (1991). Hirshman and Durante (1992) also suggest that an item's semantic characteristics may affect the latency or accuracy of its identification, and Balota (1990, in Hirshman and Durante, 1992) concurs. Hirshman and Durante do not offer clear reasons as to why this may occur though.

7.2.2.2 PRIMING EFFECTS

Firstly, it was seen that male subjects generally produced more neutral words in the *sad* subliminal priming condition. This was interpreted as a tendency to avoid spelling 'sad' meanings of words in this group. Female subjects spelled more 'sad' words than males, and did not appear to be reactive to the subliminal priming *condition*.

Secondly it was seen that with more strongly valenced words (die/dye, mourning/morning, pain/pane) deviation of the 'sad' word category due to subliminal exposure condition was close to significance for the first two items cited and exceeded the level of significance (adjusted residual >1.96) for the third. It seems too much of a coincidence that these items showed the strongest patterns of deviation for the 'sad' category, and were also rated as the three saddest words. It is thought therefore, that there was a priming effect found in these items, and that it was in a direction consistent with, and predicted by the initial hypotheses (congruent), although this tended to be stronger in some groups than others for the latter two items (mainly the male subject group).

Thirdly, with incongruent priming (i.e. a 'happy' prime was given with words in the 'sad' word list), subjects made significantly more errors. This was a main effect in the ANOVA, but significant interactions also occurred: it was most pronounced in the non-English and male groups. The explanation given for this is that the 'happy' prime was incongruent with the valence of the word which was likely to be either 'sad' or 'neutral'. The prime was therefore non-facilitative, and subjects may have had difficulty in accessing appropriately congruent words. This suggests a non-specific type of priming,

In short, the following effects are claimed:

1. A priming effect associated with the subliminal mood stimulus: a specific, mood congruent effect which was generally small, and limited to strongly negative items.
2. A priming effect related to the male group which as a whole tended to spell fewer 'sad' words. In this group there seemed to be a general avoidance of 'sad' words, and a tendency to spell neutral words - an effect opposite to the predicted.
3. A general incongruent priming effect by which errors were made in the incongruent priming condition.

The non-specific priming effect probably occurred because most of the homophone items were not sufficiently salient to the priming stimuli. The item ratings made it apparent that there were reversals in the meanings of some items, and that there were definite effects of language and gender present which affected subjects interpretation of the words. Thus, effects of mood priming were probably muddied by the fact that a substantial proportion of the subjects were hazy about word meanings - therefore priming effects were unpredictable. The finding that more errors were made in the incongruent condition seems to confirm this.

An important correlation was discovered which appears to corroborate the claim that a priming effect existed. The effect size (Cramer's *V*) was correlated with the sadness ratings of the emotionally valenced words in each homophone pair, and there was a negative correlation between the happiness ratings of these words and the effect size. Also, the most clear correlation existed between the sad-neutral difference ratings and the effect size. This suggests that the effect of the negative subliminal condition (since no significant, or even clear priming effects were found for the positive stimulus) was seen most clearly in the most negative items, and least clearly in the positive items. The general explanation offered is that subjects were sensitive to negative priming without awareness, but not to positive priming.

7.2.3 FOLLOW-UP STUDY

The experiment was done in order to test whether a change in mood occurred in response to subliminal stimulation. While no single significant mood change occurred, (although one variable approached significance, (bootstrap: $p<0.06$, sample estimate: $p<0.09$) a pattern of changes was evident in the group exposed to the *sad* stimulus whereby there were improvements in self-reported mood on 5 of the 6 factors. The only factor on which there was no change was factor *V* (*Vigour-activity*). In the group exposed to the positive mood stimulus, no changes were evident on any of the factors.

The above findings point to the conclusion that semantic analysis did occur without awareness, and that responses were affected only by the negative subliminal stimulation. The reason for the reported change in mood is not clear however, since it ran counter to predictions. The question motivating this study asked whether any reportable change in mood occurred in response to subliminal stimulation. It seems that the answer is complex, since the pattern of changes was paradoxical. Why did subjects report an improvement in mood when they were exposed subliminally to a 'sad' mood stimulus, while those exposed to a 'happy' mood stimulus reported no change? This question will be addressed in the general discussion and theoretical review which will follow.

The similarity between the Follow-up study and the Main study, is that in both, the only changes were associated with the negative subliminal stimuli, and no measurable changes were associated with the positive stimuli.

7.3 COMPARISONS WITH OTHER STUDIES

In this section, some comparisons of the results of this study are made with relevant findings of other studies.

Perhaps the single most important finding in the present thesis is that subjects were reactive only to the negative priming stimuli. It has already been mentioned that the Halberstadt *et al.* (1995) study did not observe any priming effect in the group exposed to the happy mood induction. In this respect, there is some agreement with these authors' experiment, although the mood-congruent priming found in the Main Study was neither as clear nor as strong. These authors suggest that the explanation might lie in the nature of the influences of negative and positive emotion in language processing, but they do not elaborate this idea further.

An important difference between this study, and that of Halberstadt *et al.* is that these authors were able to establish that a mood change occurred in their subjects, whereas this study did not. The follow-up study suggested that a paradoxical **improvement** in mood may have occurred in response to the stimulus. Halberstadt *et al.* established that their mood induction had been effective by rating their subjects mood with a self-report mood scale, and their conclusion that (negative) mood-congruent priming occurred was therefore justifiable.

In their research, Halberstadt *et al.* were not able to determine the stage at which the observed priming effects exerted their influence. They report findings consistent with the claim that contextual influences may influence processing in a top-down manner, and include mood as one possible influence, but these authors were not able to speculate whether the observed effects 'occurred at the level of lexical access or at a later stage of processing' (p. 281). The general conclusion of their research however, in that it was consistent with Bower's theory in which an 'emotion unit spreads activation to emotion-related lexical items in memory, thereby affording them a processing advantage' (*ibid.*).

Some support was found in the Main Study, for an emotion congruent priming effect, although this effect was small, and isolated to the most strongly negative items. It seems too, that the results may also be compared to those obtained by Kemp-Wheeler & Hill (1992) who found that emotionally aversive primes facilitated the production of (congruent) emotionally aversive target words, although these authors used decision latency time as a dependent measure: congruent primes reduced latency and vice versa.

Greenwald *et al.* (1995) predicted that priming effects could also take the form of higher error rates, although this did not occur in their study. In the Main Study, non-English subjects made significantly more errors than English subjects, especially in the *happy* subliminal condition, and males made significantly more errors than females - also in the *happy* subliminal condition (see Figures 4.5 and 4.6 in the Main Study). The explanation of Greenwald *et al.* (1995) is thought to be plausible (that errors were a function of incongruent priming in groups which, for some reason, were more sensitive to subliminal priming than others).

It is interesting, though initially confusing to compare the results of the Follow-up study to the results of the experiment of Talbot *et al.* (1991). These authors confirmed Bornstein's (1990) finding that behavioural indices are more sensitive indicators of SPA influences than either self-report measures or projective measures. However, they report that subjects exposed subliminally to the phrase 'Mommy is leaving me' reported significantly less self-confidence than subjects exposed to the phrase 'Mona is loaning it'. This was apparently due to the influence of the 'anaclitic' group in their study, since there was an interaction between group and stimulus type. The anaclitic group also scored significantly higher on the Beck Depression Inventory.

The results of the Follow-up study suggested a pattern of changes which indicated that a positive change in mood had occurred in the group exposed to the negative subliminal stimulus.

This was unexpected, and certainly different to the changes on self-report measures found in the experiment of Talbot *et al.* Perhaps the difference in response is due to the fact that the sample used in these authors' study consisted of subjects diagnosed with depression.

7.4 PREATTENTIVE BIAS STUDIES

The studies by Mogg *et al.* and Bradley *et al.* are important, and are treated separately since they are highly relevant to the findings of this thesis. These authors propose that with anxiety, a specific bias operates in favour of negative information at a preconscious level of processing. A number of studies thus point to the possibility that this bias corresponds with an automatic type of processing which takes place before awareness occurs (Mogg *et al.*,1993; Mogg *et al.*, 1995). Now Williams *et al.* (1988 in Bradley *et al.*,1994) use Graf and Mandler's (1984) distinction between *integration* and *elaboration* to characterise the difference, respectively, between automatic processes, such as word recognition, which occur without awareness, and processes which require awareness. The process of integration has been studied by assessing the effects of priming on implicit memory, i.e. these involve indirect effects, and do not involve conscious or intentional retrieval of material. Elaboration involves a more strategic process whereby words are linked to other material in memory and associations are formed. This process takes place within awareness, and can be measured by explicit memory tasks. Williams *et al.* suggest that anxiety exerts a bias in terms of the *integration* of information, whereas depressive conditions exert bias in terms of the *elaboration* of information. They produced support for this theory when they showed that anxious patients produced more (primed) threat than neutral word completions (implicit memory) when given a word stem, but not when explicit memory was directly tested in a cued recall task.

The pattern of results found in the present thesis is consistent with the findings of these authors in that subjects seemed sensitive to negative priming stimuli. The task in the Main Study, in terms of the distinction used by Williams *et al.* is comparable to the primed word completion task used by Matthews *et al.* (1989, in Bradley, *et al.*, 1994). Matthews presented word stems (a few letters of a word), and asked subjects to complete the words. Some subjects were primed subliminally by negative words, and others were primed supraliminally. Bradley *et al.* argue that 'if priming occurs due to subliminal presentation, then clearly the effect is automatic, and does not depend on conscious strategic processes' (p. 67). Thus, if the subliminal priming effect could be partialled out, the effect of the conscious strategy only (involving explicit memory) would be left. In this way, it may be theoretically possible to refer to the subliminal priming effect as testing implicit memory.

The mood priming experiment in the Main Study involved the resolution of lexical ambiguity. The homophone experiment may be understood in the following way: There was an apparent bias whereby word meanings were affected by the subliminal priming (as noted before, some congruent priming effects occurred, but mainly non-specific effects, and they were correlated with the sadness ratings of the words). This may be referred to, in the terminology of Williams *et al.* as an effect of a *bias* in integration whereby negative information was selectively attended to and processed. In other words, perception of the subliminal prime may have been affected by some kind of integrative, preconscious bias in favour of negative information.

Now, the similarity between this present thesis, the work of Halberstadt *et al.* and that of the Preattentive Bias Studies is that subjects in virtually all cases were reactive to a negative type of priming. This orientation was not unique to clinical subjects, but also occurred in non-clinical 'high negative affect' subjects too (Bradley *et al.*, 1994). The conclusion of this study is that non-clinical depression was associated 'with a mood-congruent bias in automatic aspects of memory' (*ibid.*).

In the literature consulted in this area (Mogg *et al.*,1993; Bradley, *et al.*, 1994; Mogg *et al.*, 1995), a preconscious bias for emotionally negative words was associated mainly with clinically significant anxiety, and non-clinical depression. Interference was produced in anxious and non-clinically depressed subjects, by both supraliminal and subliminal exposure of negative stimuli. This interference was not seen in the case of clinically depressed patients, nor was it seen in the non-clinical control groups.

The finding that subjects experiencing anxiety and 'negative affect' selectively process negative information suggests as (Bradley *et al.* 1995) remark, 'a natural orientation towards threatening stimuli in the environment' (p. 536). It is easy to see that aspects of the experimental situation described in the Main Study may have been anxiety-provoking for some subjects. Subjects may have been more vigilant than usual, and this vigilance could have been associated with a preattentive bias for threat, or negative information since this would naturally be salient to a state of anxiety. The bias operated at some early (integrative) stage of information processing, and was unavailable to consciousness.

A possible explanation for some of the language- and gender-specific priming effects reflected by the interactions in the ANOVA analysis is that some language and gender groups were more prone to anxiety, or experienced more negative affect, but this is mere speculation. It might therefore be suggested that generally mood in the male and non-English groups was more negative than in the female group, especially the English speaking female group where effects were generally less. An interesting aside is that males spelled significantly fewer 'sad' words than females, and more 'sad/neutral' words, and English subjects spelled significantly more 'happy' words than non-English subjects. These findings may suggest various psychodynamic interpretations, eg. that male subjects were more defensive than female subjects, and hence that their mood was more negative. It could also be inferred that non-English speaking subjects mood was less positive because of the lower number of 'happy' words produced by this group. Inferences of this kind are tentative however, and additional corroboration would be required in order to establish them more clearly.

It seems clear from this discussion, that anxious and non-clinically depressed subjects are generally more sensitive to negative information than 'normal' subjects. Several studies point to the likelihood that this bias occurs at an early stage of information processing - in the terms of Graf and Mandler (1984), at the stage of integration. These effects appear to be distinct from those encountered with recall tasks which entail awareness, and hence the elaboration of associations which takes place within awareness, and under its control.

7.5 AFFECTIVE AROUSAL AND AWARENESS

This section will discuss the question of awareness as it is related to affective arousal. The cognitive theory of mood is associated with authors such as Arnold (1960), Lazarus (1966) (both cited in Weiner, 1985) who conceive of emotions as consisting of different levels of processing and complexity. These authors suggest that there are different levels of appraisal which occur in response to a stimulus. The primary appraisal, is regarded as a 'rather primitive emotional reaction' (in Weiner, 1985, p. 560), whereas a secondary appraisal is associated with more 'advanced psychological mechanisms' referred to sometimes as 'ego defences' (*ibid.*). The essential aspect of this theory, is that the various types of arousal are relatively undifferentiated feeling states before they are given a cognitive, emotional interpretation.

The term 'affective arousal' is used to refer to the unelaborated feeling state associated with an increased level of cortical and physiological arousal. Several theorists suggest interesting links between affective arousal, and the phenomenology of emotion. These theories are potentially useful in understanding the mechanism by which experimental effects, may be evoked. In this discussion, the position taken is that emotion entails awareness, and involves a conscious appraisal and interpretation of an affective state. Emotion is therefore seen as a conscious elaboration of states of physiological and cortical arousal.

7.5.1 ATTRIBUTION THEORY

'Attribution theory' is a vast body of theory and research, and cannot be adequately reviewed here. Nevertheless, it is useful to refer to it as a possible interpretive framework. Weiner suggests that the general principle in attribution theory is that complex cognitions arise to 'refine and differentiate experience' (Weiner, 1985, p. 560). These cognitions involve appraisal, and seek causal explanations for events. Bornstein (1992). suggested a model by which SPA effects could be explained. This was a reaction to the difficulties researchers have experienced in trying to explain experimental effects psychodynamically. The traditional model used to explain SPA effects is the Ego-Defence model of which Silverman (1983, in Bornstein, 1992) and Dixon (1981, 1991) are proponents. Psychoanalytically orientated interpretations entail ego-defence constructs and these rather narrow explanations are often not tested against alternative theoretical backgrounds, as Bornstein (1992) remarks.

The phenomenon for which Bornstein sought an alternative explanatory model, is the inhibiting effect which awareness has on responding to subliminal stimuli. This finding is well established by several meta-analyses, and was discussed in the Survey of Literature. Bornstein asserts that in SPA research, drive-related messages influence behaviour by temporarily either gratifying, or exciting drives and needs. Bornstein states that SPA stimuli are all affect-laden, whether negative or positive. He suggests that SPA messages commonly increase or decrease subjects levels of anxiety, depending on the affective tone of the stimulus. This change in anxiety levels is associated with changes in subjects responses on the dependent measures used in experiments which, according to Bornstein, are deliberately formulated to be sensitive to changes in anxiety levels. When subjects become more anxious as a result of a subliminal message, Bornstein suggests that they consciously attempt to formulate an explanation. The phenomenon that 'subjects spontaneously generate causal attributions for changes in internal states' may indeed be ubiquitous (Hastie, 1984, in Bornstein, 1992). When SPA stimuli are perceived consciously, an attribution is available whereby subjects can relate their increased anxiety to the experimental message, and thereby discount it as being experimentally induced. This a type of situational attribution, and its effect is to diminish the amount of anxiety experienced. Now when a message is presented subliminally, subjects cannot attribute the increase in experienced anxiety to an external source since it occurred without awareness. Consequently, a situational attribution is not possible, and subjects are forced to the conclusion that the increase in anxiety is dispositional. There is no reduction in anxiety in this situation, and measures sensitive anxiety are affected.

It is interesting that Bornstein's explanation makes anxiety centrally important in alternately motivating attributions or evoking experimental effects. It is not altogether clear why other emotions could not play a part, or be of more central importance in this process. It seems possible that anger, for example, may be evoked by stimuli such as 'Leaving mom is wrong' (Dauber, 1984). Different emotions - specifically linked to the subliminal stimuli, could cause a shift in subjects' affective state, and energise experimental effects. On the other hand, it is interesting that Bornstein singles out anxiety as being of central importance in terms of subliminal stimulation. This suggests links to the Preattentive Bias Studies, but the nature of the link is not clear.

7.5.2 PHYSIOLOGICAL AROUSAL, COGNITION AND EMOTION

Schachter and Singer (1962) conducted an interesting series of experiments in which they examined the relationship between cognition and physiological arousal. (Again, a vast literature has developed around their findings and this literature cannot be adequately reviewed here. I simply wish to refer to this literature in order to develop an interpretation of the findings of the present research). They suggested that cognitive factors are determinants of mood, and they have a guiding, or 'steering' function in relation to the experience of physiological arousal.

Thus, emotions are guided by cognitive factors which label and interpret internal states of arousal, as these authors put it, '...in terms of the characteristics of the precipitating situation... (p. 380). The resulting emotional state, these authors suggest, is a 'function of a state of physiological arousal and of a cognition appropriate to this arousal' (*ibid.*).

Schachter and Singer's research was an attempt to answer the question of how a person would respond when a state of physiological arousal was induced, 'for which no immediately explanatory or appropriate cognitions were available' (*ibid.*). If, for example, subjects were covertly given epinephrine, a state of physiological arousal would exist, but they would be unaware of why they felt this way. Schachter (1954, in Schachter and Singer, 1962) suggested that this would lead to the arousal of what he termed 'evaluative needs'. This is the need one would have to understand and label one's feelings. These authors conducted an experiment in which subjects were injected with epinephrine, and then placed in various contrived situations in which certain moods (namely anger and euphoria) were suggested by the behaviour of a 'stooge'. They found a pattern of results consistent with the predictions that subjects were susceptible to the stooge's mood, and tended to label their state in terms of the cognitions available to them.

The pattern of results seen in these authors' study is of interest to the present thesis since the situation where subjects experienced physiological arousal, but were unaware of the reason for this arousal, seems comparable to the situation where a subject has been exposed to an emotionally-laden subliminal stimulus, and has no way of explaining the resulting level of arousal. In such a situation, if it were similar to that described by Schachter and Singer (1962), subjects would have a need to find reasons for this state of arousal, and would tend to describe their emotions in terms of available cognitions. Clearly, the experimental situation would be regarded as a source of explanations.

This explanation is strikingly similar to that described by Bornstein (1992) who suggested that subjects would seek attributions to account for their increased (in terms of his explanation) levels of anxiety. Bornstein suggests that when no appropriate attributions are available, subjects experimental behaviour will increase in terms of dependent measures which are sensitive to the effects of anxiety.

The important aspect of these explanations is the suggestion that following a change in arousal, there is a conscious search for explanatory cognitions, or attributions which would **elaborate** the state of arousal and allow it to be understood and explained in terms of a particular emotion.

7.5.3 INTERPRETATION OF FOLLOW-UP STUDY RESULTS

The results of the Follow-up study were puzzling since a paradoxical improvement in mood was observed in the group exposed to the 'sad' stimulus. The question was posed, 'Why did subjects report an improvement in mood when they were exposed subliminally to a 'sad' mood stimulus, while those exposed to a 'happy' mood stimulus reported no change'. An answer to this question will be ventured on the basis of the theory on affective arousal and awareness.

Bornstein (1992) suggests that anxiety results from subliminal exposure of aversive stimuli, and that this is reflected in dependent measures which are sensitive to the effects of anxiety. Schachter and Singer (1962) offered a model with some interesting similarities to that of Bornstein. The common element is that subjects, when faced with a change in levels of arousal will actively seek explanations, primarily from the 'characteristics of the precipitating situation'. In addition, Schachter and Singer found that subjects in this situation were highly suggestible to situational explanations or attributions. Bornstein asserted that when situational attributions were unavailable, subjects would not be able to discount the shift as arising from the experiment, and hence would be unable to achieve a downward regulation of their arousal levels. This would lead to changed behaviour on dependent variables sensitive to anxiety.

It is interesting to speculate that subjects exposed to the 'sad' stimulus in the Follow-up study might have reacted to their negative arousal in terms of the demands of the experimental situation. The subjects were naive in the sense that they did not know what the subliminal stimulus phrase was. However, they had already participated in an experiment in which they were exposed to subliminal stimulation. They were also required to write up the experiment as an assignment, and were assigned a certain amount of reading in the area. By the time they came to participate in the Follow-up study, subjects were fairly well-informed on the subject.

The experiment was introduced as a study of the effects of subliminal stimulation on mood, and the dependent measure was a direct measurement of the subjects' mood. Because of this, the experiment may have been rather focussed on mood, and this could have created an expectation in the subjects that their mood would change, hence an increased likelihood that changes would be framed in terms of mood. An awareness that their mood was being assessed may have been threatening to the subjects who were exposed to the 'sad' stimulus and experienced negative arousal. These subjects would not have had any discounting attributions available from the situation, although they would have been consciously aware of the fact that their mood was of central interest in the experiment. The negative arousal would have been threatening, and they may have become defensive because of their inability to account for it, and thereby lower it. Now the perception and processing of the negative stimulus must have taken place without their awareness. They would not have been consciously aware of the nature of the threat, though they were primed to believe that their mood might change.

If these subjects had not been exposed to the negative stimulus, and experienced negative arousal, the need for an attribution would not have arisen, and presumably, no change in mood would have been reported, as appeared to be the case with the subjects exposed to the 'happy' stimulus.

The dependent measure required subjects to reflect on their mood. Subjects who felt an ill-defined sense of threat or anxiety, would presumably act in accordance with this, i.e. react defensively, or adaptively in order to counter the threat, given the non-availability of attributions by which the anxiety could be discounted, especially if their mood was being monitored, and represented an additional source of threat. If they had seen the stimulus, the threat could have been countered more directly and perhaps the negative state could have been avoided because the threat could be discounted as an experimental manipulation, and subjects could have attenuated their anxiety.

Perhaps, because subjects consciously needed to cope with the demands of the experimental situation (and not withdraw from it, since this would cause embarrassment), their negative arousal would be incapacitating, although presumably if the threat had increased - eg. if the experimenter had threatened subjects with a knife, they would have adopted a strategy which was appropriate to this direct level of threat. Because of the attention that was focussed on their mood, subjects may consciously have reinterpreted, or construed their arousal as positive because of their need to cope with the demands of the situation.

In short, because subjects experiencing a state of arousal for which they have no explanation are thought to be suggestible (Schachter and Singer, 1962), the situation may have cued subjects to strategically interpret their mood as positive, since negative self-reports of mood could have reinforced their anxiety, and been non-adaptive in an already threatening situation. The admittedly curious conclusion is therefore suggested, that subjects exposed subliminally to the negative stimulus showed indirect effects (paradoxical improvements) on a direct measure of mood, while those exposed to a positive subliminal stimulus showed no change.

7.5.4 IMPLICATIONS FOR SUBLIMINAL PERCEPTION RESEARCH

It is interesting to link the previous discussion of arousal, cognition, and emotion with the earlier discussion of subliminal perception presented in the Review of Literature. A number of authors pointed to the finding that conscious awareness of stimuli is needed in order for strategising to occur (eg. Marcel, 1980, 1983; Cheesman & Merikle, 1986). This distinguishes subliminal from supraliminal processing of stimuli. Bornstein (1992) showed that stimulus unawareness was needed for the production of SPA effects. It seems likely that awareness is associated with subjects being able to make inferences about their internal states of arousal, and as Bornstein and Schachter and Singer suggest, subjects appear to have a need to find explanations for these shifts in arousal. When stimuli are presented within awareness, subjects are able to reflect consciously and strategically about the task - this was also suggested by Marcel, and Cheesman and Merikle *(op cit.)*, and this agrees with Bornstein's theory that when subjects are aware of stimuli, they are able to strategically discount them as being 'not real' and thereby attenuate their feelings of anxiety.

By contrast, there is a consistent finding that semantic analysis occurs when subjects are exposed subliminally to stimuli, but this is not accompanied by more integrative, higher level types of processing. The distinction between conscious and unconscious processing is therefore captured by the differences observed between above and below threshold responses to experimental stimuli, and the difference is attributed to levels of awareness. This distinction fits with Bornstein's attribution theory, in that subjects are only able to neutralise arousal when they are able to consciously generate situation attributions, and this may only occur when they are aware of stimuli.

Bornstein accepts that attribution theory is not incompatible with a *defence mechanism* theory. The implication of his theory is that subjects' regulation of their negative arousal is self-protective. Bornstein makes the point that the notion of 'discounting attributions' is more acceptable to the experimental psychologist than that of 'ego defences' since in his view, the former is more clearly tied to a 'solid foundation of empirical research', and is easier to operationalise.

The *Preattentive Bias Studies* suggest that with anxiety and non-clinical depression, there is a preattentive bias in favour of negative information. This bias occurs at an automatic stage of information processing, and does not require higher level processing. Their findings are compatible with the general theory that processing of stimuli below the threshold of awareness takes place in a automatic manner, and is not accompanied by the higher order types of processing seen when subjects are aware of stimuli. The authors of these studies use Graf and Mandler's distinction between integration and elaboration to refer to the difference between the two types of processing, and these correspond well with the distinctions described by other authors.

It would be of interest to elaborate Dixon's notion of perceptual defences in terms of the findings of the *Preattentive Bias Studies*, since both theories refer to bias in the perception of information in terms of its emotional valence.

It is difficult to comment on the relationship between conscious and unconscious processes (see Section 2.6.5.1) in terms of whether they are associated or not. Greenwald *et al.* suggested that 'when stimuli produce unconscious effects, they also produce associated but perceptually indistinct conscious effects' (1995, p. 23). In the preceding discussion, it was suggested that when a (negatively) emotionally loaded stimulus was presented below the recognition threshold, arousal resulted, and a conscious process of 'seeking attributions' was activated. This suggests that conscious processes by which individuals strategically, perhaps self-defensively seek explanations for changes in arousal are related to the unconscious process which caused the arousal in the first place. To this extent, they seem to be dissociated. Perhaps conscious processes are supervenient on unconscious processes, but not independent of them. The link between conscious and unconscious processes is certainly intriguing, and a number of questions are raised by subliminal methodology.

In summary, it seems that the research done for this thesis has tentatively established a number of links with other authors. The pattern of results obtained suggests that modest mood-congruent priming effects were found in the most negative homophone items. This agreed with the finding of Halberstadt *et al.* that mood-congruent recall may be elicited for a negative mood induction (but not for a positive mood induction), but extends this research by the possibility that a subliminal mood-congruent priming effect was demonstrated. A number of non-specific effects were associated with the negative priming, and the size of the effect was predicted by the sadness ratings of the items. This finding might be explained by the findings of the *Preattentive Bias Studies* in that subjects who were most sensitive to priming, might have experience negative affect - an effect shown by the authors of this study. There is certainly a strong link between the findings of this thesis, and those of other researchers in that subjects tend to respond to negative stimuli, and not to positive stimuli (a major exception being the symbiotic oneness studies).

The Follow-up Study also suggested that subjects were sensitive to the effects of negative subliminal priming, but not positive subliminal priming. This was inferred from a pattern of improvements in mood in subjects who were exposed to the negative mood stimulus. The reason for this improvement in mood was explained in terms of Schachter and Singer's (1962) theory of emotion, and Bornstein's (1992) attributional theory. It was suggested that attribution theory was compatible with a the idea that individuals seek attributions for their mood changes as part of a strategy of self-regulation and self-protection. (A notion which seems compatible with certain psychic defences - those that operate within consciousness). When consciousness is bypassed, as is thought to occur in the case of subliminal stimulation, conscious strategies cannot be used, to explain and counter the change in arousal, and indirect anxiety-related effects occur. It is possible that some of the SPA findings may be explained by this mechanism.

7.6 LIMITATIONS OF THE PRESENT STUDIES

This research project began with the author's interest in developing a technique of subliminal stimulation which could utilise the common computer, and *VGA* screen, since a tachistoscope was not available. All the work that followed the development of a masking by visual noise procedure was of a tentative nature. Since I have never tried this method of subliminal stimulation before, the data admittedly, was subjected to intensive examination - far beyond hypothesis testing as it is done in the usual rigorous, scientific way. It would have been easy to simply declare that the experiment had shown a null finding, and to have left it at that. However, it seemed apparent at several stages that the data contained patterns, and these were tantalising. It has to be admitted though, that much of the theorising has been of a *post hoc* nature, and the results described must be treated cautiously.

The basic argument used in this thesis is that a pattern of differences is not likely to be due to randomness. There was a pattern of specific (mood-congruent) and non-specific differences in word spelling associated with the subliminal priming in the Main Study. An independent sample of subjects emotional ratings of the items was correlated with the effect size (positive correlation between the sadness rating, a weaker, negative correlation with the happiness ratings, and a strong positive correlation between the effect size and a measure of the sadness of the items when the neutral ratings were subtracted from them). In the Follow-up Study, there was a pattern of differences in the mood scores between the two subliminal exposure conditions and again, these differences were associated with the negative subliminal priming. There were no differences seen in the group exposed to the positive priming stimulus. Another argument is that links have been suggested with the findings of other experimenters in this and related areas. This fact also suggests that the findings of this study are not due to randomness. It would be important to replicate the findings of this thesis in a future series of experiments. Successful replications would reduce the possibility that these findings were due to chance.

Some specific problems of the research have been pointed out already, but a general weakness of the design has been the lack of a supraliminal control condition. Comparisons were made between the 'sad' and 'happy' stimulus phrases when they were both exposed subliminally, but not when they were exposed supraliminally. This would need to be done in order for valid comparisons between aware and non-aware conditions to be made.

It appeared the many of the homophones were unsuitable because of the nature of the priming effect. The magnitude of the effect may have been diminished as a result of the delay between the presentation of the prime, and the presentation of the homophone. In a future study, it would be interesting to interleave priming with presentation of items in order to increase proximity, and possibly enhance the effect of priming.

It would have been useful to add in another dependent measure such as response latency. This would be another way of testing facilitation vs. non-facilitation. This would have provided additional information in the homophone task.

It would have been useful to have run forced-choice tests in order to test for awareness. Besides a simple free-recall test asking subjects to recall any of the words they saw, this would have given additional information regarding stimulus identification.

Because of the amount of variation between items in the Main Study with regard to gender and home language differences, it would have been useful to have had a more homogenous sample. Also, given the possible link between negative mood, it would have been useful if subjects mood had been assessed on various relevant dimensions before the task, so that a possible relationship between subliminal sensitivity and anxiety could be elucidated.

The nature of the inferences drawn with regard to mood is complicated - this was seen especially with the Follow-up Study when a direct measurement of subjects' mood was made before and after subliminal stimulation. The interpretation of this finding is admittedly sketchy, and requires further elaboration. It would be useful to have physiological measures of arousal, such as galvanic skin response, EMG (electromyogram), and EEG (electroencephalogram) measures to compare the self-reports with, and assess whether claims that subliminal stimulation causes a change in levels of arousal have any empirical foundation.

7.7 CONCLUSION

The findings of the various experiments were discussed in this chapter, and compared with the findings of other authors. A number of similarities emerged. It is suggested that small mood-congruent priming effects were seen in the Main Study, along with some non-specific effects associated with the subliminal priming condition. The sensitivity to negative information presented below the threshold of awareness found in the Main Study corresponds with the preconscious processing bias found in the *Preattentive Bias Studies*. Generally, anxiety seems to have a major role in evoking experimental effects, and these studies indicated that both clinically significant anxiety and non-clinical depression were predictors of sensitivity to negative subliminal information. Bornstein's theory of attribution, also singled out anxiety as having a major role in SPA effects.

Generally, there are large areas where SPA and non-psychoanalytically orientated research complement each other. SPA research has emphasized the clinical aspects of subliminal stimulation, but the non-psychoanalytically orientated research has provided support for the claims made by researchers of the former persuasion by demonstrating that semantic priming effects exist. Both SPA research and non-psychoanalytically orientated research suggests that different type of processing occur when stimuli are perceived with and without awareness, and this is an important area of common ground.

An interpretation, based on attribution theory, and Schachter and Singer's theory of emotion was suggested to explain the results of the Follow-up Study. This may be related to theories of defence mechanisms in the sense that an adaptive strategy may have adopted by subjects who were exposed subliminally to a negative mood suggestion. This may have been a reaction to the demands of the situation.

Given the substantial body of research on subliminal research, it would seem that it is fairly well established as a worthy field of investigation. The conclusion reached by this author, is that further research into the nature of subliminal effects is warranted. In particular, it would be interesting to investigate electrophysiological correlates of subliminal stimulation.

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APPENDIX A

MASKING BY LIGHT: *PASCAL* SOURCE CODE

```
Program Pilot_test 1;
{version 4.3C }
{MASKING BY LIGHT}

USES Crt;

VAR
Infile1 : TEXT;
Infile2 : TEXT;
Outfile : TEXT;
Person : String[30];
Filename1: String[25];
Filename2: String[25];
Fileout: String[25];
Phrase : Char;
Intensity : Integer;

CONST Defaultfile1 ='c:pilot\recog.dat';
    Defaultfile2 ='c:\pilot\stim.dat';
    Factor = 0.215;

Procedure Calibrate;
BEGIN
 ClrScr;
 Write(' CALIBRATION CHECK, PLEASE ADJUST MONITOR TO STANDARD BRIGHTNESS.');
 Writeln;
 Write('                BRIGHT CHARACTERS');
 Writeln;
 Delay(10000);{only 2 seconds - multiply by factor of 0.2}
 Write('          When check is finished, press a key.');
 ClrScr;
 TextBackground(White);
 ClrScr;
 REPEAT
 UNTIL Keypressed = TRUE;
 TextBackground(Black);
 ClrScr;
END;

Procedure Prompt;
BEGIN
 Write('>> ');
END;

Procedure Record_brightness;
VAR Brightness : INTEGER;
BEGIN
 TextColor(Yellow);
 Write('          Please enter SCREEN BRIGHTNESS SETTING');
 Writeln;
 Prompt;
 Readln(Brightness);
 Write(Outfile,'Brightness setting is: ',Brightness,' mV');
 Writeln(Outfile);
 TextColor(Lightgray);
 ClrScr;
 Write('Choose intensity of screen for test: 1=light 2=dark');
```

```
 Writeln;
 Prompt;
 Readln(Intensity);
 Intensity:=Intensity + 6;
 IF Intensity = 7 THEN
  BEGIN
   Write(Outfile,'Intensity=LightGrey');
  END;
 IF Intensity = 8 THEN
  BEGIN
   Write(Outfile,'Intensity=DarkGrey');
  END;
 Writeln(Outfile);
 ClrScr;
END;

Procedure Name;
BEGIN
 Write('  Please enter name - First name, Surname. Then press E N T E R');
 Writeln;
 Write('  _______________________________');
 Writeln;
 Prompt;
 Readln(Person);
 ClrScr;
END;

Procedure Open_Files(Person : String);
VAR
IOErr : Integer;
GO : Char;
BEGIN
 REPEAT
  Writeln;
  Writeln;
  Write('THIS IS THE C VERSION. Press any key to GO');
  Writeln;
  Prompt;
  REPEAT
  UNTIL Keypressed = True;
  Filename1 := Defaultfile1;
  Filename2 := Defaultfile2;
  Assign (Infile1, Filename1);
  Assign (Infile2, Filename2);
  {$I-}
  Reset(Infile1);
  Reset(Infile2);
  {$I+}
  IOErr := IOResult;
  UNTIL (IOErr =0);
  Writeln;
  Writeln;
  Write('Enter path and output file name [eg. a:subjct1.dat}');
  Writeln;
  Prompt;
  Readln(Fileout);
  Assign(Outfile,Fileout);
```

```
  Rewrite (Outfile);
  Write(Outfile,'Subject: ',Person);
  Writeln(Outfile);
  ClrScr;
END;

Procedure Close_files;
BEGIN
 Close(Infile1);
 Close(Infile2);
 Close(Outfile);
END;

Procedure Space;
BEGIN
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
END;

Procedure Space1;
BEGIN
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
END;

Procedure Pause;
BEGIN
 Writeln;
 TextColor(Red);
 Write(' TO CONTINUE, PRESS A KEY');
 Prompt;
 REPEAT
 UNTIL Keypressed =TRUE;
 TextColor(Lightgray);
END;

Procedure Focus;
VAR Shift : INTEGER;
BEGIN
 ClrScr;
```

```
 Space;
 FOR Shift:= 1 to 39 DO
 BEGIN
  Write(' ');
 END;
 Write(Chr(1));
 Space;
 Delay (25000);{25000}
END;

Procedure Spaceloop;
VAR Centre : INTEGER;
BEGIN
 Write('                    ');
END;

Procedure Spaceloop1;
BEGIN
 Write('                    ');
END;

Procedure Blank;
VAR Block,Line : INTEGER;
BEGIN
 ClrScr;
 Space1;
 Textcolor(White);
 FOR Line:= 1 TO 3 DO
 BEGIN
  Spaceloop1;
  FOR Block := 1 to 22 DO
  BEGIN
   Write(Chr(219));
  END;
  Writeln;
 END;
 Delay(5000);{old value 5000 - seemed cool}
 TextColor(LightGray);
END;

Procedure Flash(Flashtime : Integer; Stimulus : String);
BEGIN
 ClrScr;
 Space;
 Spaceloop;
 TextColor(Intensity);{7=LightGrey; 8=DarkGray}
 Write(Stimulus);
 Delay(Flashtime);
 Blank;
END;

Procedure Inform;
VAR Stimulus : String[25];
  Flashtime : INTEGER;
BEGIN
 ClrScr;
 Writeln;
```

```
Writeln;
Writeln;
TextColor(Green);
FOR Flashtime:= 1 TO 4 DO
BEGIN
  Write('                    VISUAL EXERCISE');
  Writeln;
END;
Writeln;
Writeln;
Writeln;
Textcolor(Red+Blink);
Writeln;
Write('                A DEMONSTRATION WILL FOLLOW');
Delay(10000);
Textcolor(LightGray);
ClrScr;
Write('  You will first see a focusing spot in the middle of the screen.');
Writeln;
Write('  Then you will see a phrase flashed very quickly on the screen');
Writeln;
Write('     followed by a white block which will cover the phrase.');
Writeln;
Write('  You need to look carefully at the focussing spot, and see if you');
Writeln;
Write('          can see the phrase which follows it.');
Writeln;
Pause;
ClrScr;
Write('This is what you will see... Wait a moment!');
Delay(10000);
ClrScr;
Focus;
Flashtime:=1000;
Stimulus:='test phrase: LOOK HARD';
Flash(Flashtime, Stimulus);
ClrScr;
Write('  There will be ten phrases in the test, each repeated ten times.');
Writeln;
Write('For each one, please watch the focussing dot in the centre of the screen');
Writeln;
Write('     and try as hard as you can to see the phrase which will be ');
Writeln;
Write('                flashed on the screen.');
Writeln;
TextColor(Blue);
Writeln;
Write('Press ENTER to continue');
Prompt;
Readln(Stimulus);
TextColor(Lightgray);
ClrScr;
END;

Procedure Recall(Stimulus: String; Flashtime, Loop1 : INTEGER);
VAR
 Answer : String[30];
```

```
 Flag : Boolean;
 Reply : Char;
 Real_time : Real;
BEGIN
 Flag := FALSE;
 ClrScr;
 Writeln;
 Write('If you were able to see the phrase, type "y".');
 Writeln;
 Prompt;
 Readln(Answer);
 IF (Reply ='Y') OR (Answer = 'y') THEN Flag := TRUE;
 IF Flag = TRUE THEN
 BEGIN
  Write(Outfile,'Subject indicates that phrase was seen.');
  Writeln(Outfile);
  Write(Outfile,'Test Phrase was: ',Stimulus);
  Writeln(Outfile);
  Real_time:=Flashtime*Factor;
  Write(Outfile,'ACTUAL Exposure time was: ',Real_time:5:2,' milliseconds');
  Writeln(Outfile);
  ClrScr;
  Write('        Please type out the phrase, then PRESS ENTER');
  Writeln;
  Prompt;
  Readln(Answer);
  Write(Outfile,'Subject recalled the following phrase: ',Answer);
 END;
 IF Flag = FALSE THEN
 BEGIN
  Write(Outfile,'Subject was not able to recall phrase');
  Writeln(Outfile);
  Write(Outfile,'Test Phrase was: ',Stimulus);
  Writeln(Outfile);
  Real_time:=Flashtime*Factor;
  Write(Outfile,'ACTUAL Exposure time was: ',Real_time:5:2,' milliseconds');
  Writeln(Outfile);
  ClrScr;
  Write('       Please have a guess at what the phrase was.');
  Writeln;
  Write('    Type out what you think it was, then PRESS ENTER.');
  Writeln;
  Prompt;
  Readln(Answer);
  Write(Outfile,'Subject guessed the following phrase: ',Answer);
 END;
END;

Procedure Recognise(Loop1 : Integer);
VAR
Loopy : INTEGER;
Rec_phrase : String[25];
Correct : INTEGER;
Answer : Char;
BEGIN
 CLrScr;
 Writeln;
```

```
 Write('    You will now see below, a list of phrases, each numbered.');
 Writeln;
 Write('  See if you are able to recognise the phrase you saw earlier');
 Writeln;
 Write('                   in the last trial');
 Writeln;
 Writeln;
 FOR Loopy:= 1 to 5 DO
 BEGIN
  Readln(Infile1,Rec_phrase);
  Write(Loopy,'.  ',Rec_phrase);
  Writeln;
 END;
 Readln(Infile1,Correct);
 Writeln;
 Write('Please type the number of the phrase displayed which is the same');
 Writeln;
 Write('        as the one you saw earlier, and PRESS ENTER.');
 Writeln;
 Prompt;
 Readln(Answer);
 Writeln(Outfile);
 Write(Outfile,'The CORRECT ANSWER WAS: ',Correct);
 Writeln(Outfile);
 Write(Outfile,'The ANSWER GIVEN WAS: ',Answer);
 Writeln(Outfile);
 Write(Outfile,'END OF TEST ',Loop1,'  ********************************************');
 Writeln(Outfile);
 Writeln(Outfile);
 ClrScr;
END;


Procedure Expose;
VAR
Stimulus : String[25];
Loop1, Loop2, Flashtime : Integer;
BEGIN
 Flashtime := 220; {effective 45ms... down to 4 ms}
 ClrScr;
 {Inform;}
 FOR Loop1 := 1 TO 10 DO {changed}
 BEGIN
  Flashtime := Flashtime - 20;
  Write(Outfile,'BEGINNING OF TEST ',Loop1,'.');
  Writeln(Outfile);
  Readln (Infile2,Stimulus);
  FOR Loop2 := 1 TO 10 DO
  BEGIN
   Focus;
   Flash(Flashtime,Stimulus);
  END;
  Recall(Stimulus, Flashtime, Loop1);
  Recognise(Loop1);
 END;
END;
```

```
BEGIN
 DirectVideo:=True;
 CheckSnow:=False;
 TextColor(LightGray);
 Calibrate;
 Name;
 Open_Files(Person);
 Record_brightness;
 Inform;
 Expose;
 Close_files;
END.
```

APPENDIX B

MASKING BY VISUAL NOISE: *PASCAL* SOURCE CODE

```
Program Pilot_test;
{version 20.3A masking by visual noise}

USES Crt;

VAR
Infile1 : TEXT;
Infile2 : TEXT;
Outfile : TEXT;
Person : String[30];
Filename1: String[25];
Filename2: String[25];
Fileout: String[25];
Phrase : Char;
Intensity : Integer;

CONST Defaultfile1 ='c:\pilot\recog.dat';
    Defaultfile2 ='c:\pilot\stim.dat';
    Factor = 0.215;

Procedure Calibrate;
BEGIN
 ClrScr;
 Write(' CALIBRATION CHECK, PLEASE ADJUST MONITOR TO STANDARD BRIGHTNESS.');
 Writeln;
 Write('                BRIGHT CHARACTERS');
 Writeln;
 Delay(10000);{only 2 seconds - multiply by factor of 0.2}
 Write('          When check is finished, press a key.');
 ClrScr;
 TextBackground(White);
 ClrScr;
 REPEAT
 UNTIL Keypressed = TRUE;
 TextBackground(Black);
 ClrScr;
END;

Procedure Prompt;
BEGIN
 Write('>> ');
END;

Procedure Record_brightness;
VAR Brightness : INTEGER;
BEGIN
 TextColor(Yellow);
 Write('          Please enter SCREEN BRIGHTNESS SETTING');
 Writeln;
 Prompt;
 Readln(Brightness);
 Write(Outfile,'Brightness setting is: ',Brightness,' mV');
 Writeln(Outfile);
 TextColor(Lightgray);
 ClrScr;
 Write('Choose intensity of screen for test: 1=light 2=dark');
 Writeln;
```

```
 Prompt;
 Readln(Intensity);
 Intensity:=Intensity + 6;
 IF Intensity = 7 THEN
  BEGIN
   Write(Outfile,'Intensity=LightGrey');
  END;
 IF Intensity = 8 THEN
  BEGIN
   Write(Outfile,'Intensity=DarkGrey');
  END;
 Writeln(Outfile);
 ClrScr;
END;

Procedure Name;
BEGIN
 Write('  Please enter name - First name, Surname. Then press E N T E R');
 Writeln;
 Write('  _______________________________');
 Writeln;
 Prompt;
 Readln(Person);
 ClrScr;
END;

Procedure Open_Files(Person : String);
VAR
 IOErr : Integer;
 GO : Char;
BEGIN
 REPEAT
  Writeln;
  Writeln;
  Write('THIS IS THE C VERSION. Press any key to GO');
  Writeln;
  Prompt;
  REPEAT
  UNTIL Keypressed = True;
  Filename1 := Defaultfile1;
  Filename2 := Defaultfile2;
  Assign (Infile1, Filename1);
  Assign (Infile2, Filename2);
  {$I-}
  Reset(Infile1);
  Reset(Infile2);
  {$I+}
  IOErr := IOResult;
  UNTIL (IOErr =0);
  Writeln;
  Writeln;
  Write('Enter path and output file name [eg. a:subjct1.dat}');
  Writeln;
  Prompt;
  Readln(Fileout);
  Assign(Outfile,Fileout);
  Rewrite (Outfile);
```

```
  Write(Outfile,'Subject: ',Person);
  Writeln(Outfile);
  ClrScr;
END;

Procedure Close_files;
BEGIN
 Close(Infile1);
 Close(Infile2);
 Close(Outfile);
END;

Procedure Space;
BEGIN
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
END;

Procedure Space1;
BEGIN
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln;
END;

Procedure Pause;
BEGIN
 Writeln;
 TextColor(Red);
 Write(' TO CONTINUE, PRESS A KEY');
 Prompt;
 REPEAT
 UNTIL Keypressed =TRUE;
 TextColor(Lightgray);
END;

Procedure Focus;
VAR Shift : INTEGER;
BEGIN
 ClrScr;
 Space;
```

```
 FOR Shift:= 1 to 39 DO
 BEGIN
  Write(' ');
 END;
 Write(Chr(1));
 Space;
 Delay (25000);
END;

Procedure Spaceloop;
VAR Centre : INTEGER;
BEGIN
 Write('                    ');
END;

Procedure Spaceloop1;
BEGIN
 Write('                    ');
END;

Procedure Blank;
VAR Block,Line: INTEGER;
BEGIN
 RANDOMIZE;
 ClrScr;
 Space1;
{ Textcolor(White);}
 Writeln;
{ FOR Line:= 1 TO 3 DO}
{ BEGIN}
   Spaceloop1;
   FOR Block := 1 to 22 DO {was 22}
   BEGIN
    Write(Chr(Random(69)+176));
   END;
   Writeln;
{ END;}
 Delay(5000);
 TextColor(LightGray);
END;

Procedure Flash(Flashtime : Integer; Stimulus : String);
BEGIN
 ClrScr;
 Space;
 Spaceloop;
 TextColor(Intensity);{7=LightGrey; 8=DarkGray}
 Write(Stimulus);
 Delay(Flashtime);
 Blank;
END;

Procedure Inform;
VAR Stimulus : String[25];
   Flashtime : INTEGER;
BEGIN
 ClrScr;
```

```
 Writeln;
 Writeln;
 Writeln;
 TextColor(Green);
 FOR Flashtime:= 1 TO 4 DO
 BEGIN
   Write('                    VISUAL EXERCISE');
   Writeln;
 END;
 Writeln;
 Writeln;
 Writeln;
 Textcolor(Red+Blink);
 Writeln;
 Write('                 A DEMONSTRATION WILL FOLLOW');
 Delay(20000);
 Textcolor(LightGray);
 ClrScr;
 Write('   You will first see a focusing spot in the middle of the screen.');
 Writeln;
 Write('   Then you will see a phrase flashed very quickly on the screen');
 Writeln;
 Write('     followed by random characters which will cover the phrase.');
 Writeln;
 Write('   You need to look carefully at the focussing spot, and try your ');
 Writeln;
 Write('           best to see the phrase which follows it.');
 Writeln;
 Pause;
 ClrScr;
 Write('This is what you will see... Wait a moment!');
 Delay(10000);
 ClrScr;
 Focus;
 Flashtime:=10000;
 Stimulus:='test phrase: LOOK HARD';
 Flash(Flashtime, Stimulus);
 ClrScr;
 Write('   There will be ten phrases in the test, each repeated ten times.');
 Writeln;
 Write('For each one, please watch the focussing dot in the centre of the screen');
 Writeln;
 Write('      and try as hard as you can to see the phrase which will be ');
 Writeln;
 Write('                   flashed on the screen.');
 Writeln;
 TextColor(Blue);
 Writeln;
 Write('Press ENTER to continue');
 Prompt;
 Readln(Stimulus);
 TextColor(Lightgray);
 ClrScr;
END;

Procedure Recall(Stimulus: String; Flashtime, Loop1 : INTEGER);
VAR
```

```
Answer : String[30];
Flag : Boolean;
Reply : Char;
Real_time : Real;
BEGIN
 Flag := FALSE;
 ClrScr;
 Writeln;
 Write('If you were able to see the phrase, type "y".');
 Writeln;
 Prompt;
 Readln(Answer);
 IF (Reply ='Y') OR (Answer = 'y') THEN Flag := TRUE;
 IF Flag = TRUE THEN
 BEGIN
   Write(Outfile,'Subject indicates that phrase was seen.');
   Writeln(Outfile);
   Write(Outfile,'Test Phrase was: ',Stimulus);
   Writeln(Outfile);
   Real_time:=Flashtime*Factor;
   Write(Outfile,'ACTUAL Exposure time was: ',Real_time:5:2,' milliseconds');
   Writeln(Outfile);
   ClrScr;
   Write('       Please type out the phrase, then PRESS ENTER');
   Writeln;
   Prompt;
   Readln(Answer);
   Write(Outfile,'Subject recalled the following phrase: ',Answer);
 END;
 IF Flag = FALSE THEN
 BEGIN
   Write(Outfile,'Subject was not able to recall phrase');
   Writeln(Outfile);
   Write(Outfile,'Test Phrase was: ',Stimulus);
   Writeln(Outfile);
   Real_time:=Flashtime*Factor;
   Write(Outfile,'ACTUAL Exposure time was: ',Real_time:5:2,' milliseconds');
   Writeln(Outfile);
   ClrScr;
   Write('      Please have a guess at what the phrase was.');
   Writeln;
   Write('   Type out what you think it was, then PRESS ENTER.');
   Writeln;
   Prompt;
   Readln(Answer);
   Write(Outfile,'Subject guessed the following phrase: ',Answer);
 END;
END;


Procedure Recognise(Loop1 : Integer);
VAR
Loopy : INTEGER;
Rec_phrase : String[25];
Correct : INTEGER;
Answer : Char;
BEGIN
```

```
ClrScr;
Writeln;
Write('    You will now see below, a list of phrases, each numbered.');
Writeln;
Write('  See if you are able to recognise the phrase you saw earlier');
Writeln;
Write('                    in the last trial');
Writeln;
Writeln;
FOR Loopy:= 1 to 5 DO
BEGIN
  Readln(Infile1,Rec_phrase);
  Write(Loopy,'.  ',Rec_phrase);
  Writeln;
END;
Readln(Infile1,Correct);
Writeln;
Write('Please type the number of the phrase displayed which is the same');
Writeln;
Write('        as the one you saw earlier, and PRESS ENTER.');
Writeln;
Prompt;
Readln(Answer);
Writeln(Outfile);
Write(Outfile,'The CORRECT ANSWER WAS: ',Correct);
Writeln(Outfile);
Write(Outfile,'The ANSWER GIVEN WAS: ',Answer);
Writeln(Outfile);
Write(Outfile,'END OF TEST ',Loop1,'  ******************************************');
Writeln(Outfile);
Writeln(Outfile);
ClrScr;
END;


Procedure Expose;
VAR
Stimulus : String[25];
Loop1, Loop2, Flashtime : Integer;
BEGIN
 Flashtime := 420; {effective 81.7ms... down to 4 ms}
 ClrScr;
 {Inform;}
 FOR Loop1 := 1 TO 10 DO {changed}
 BEGIN
  Flashtime := Flashtime - 40;
  Write(Outfile,'BEGINNING OF TEST ',Loop1,'.');
  Writeln(Outfile);
  Readln (Infile2,Stimulus);
  FOR Loop2 := 1 TO 10 DO
  BEGIN
   Focus;
   Flash(Flashtime,Stimulus);
  END;
  Recall(Stimulus, Flashtime, Loop1);
  Recognise(Loop1);
 END;
```

```
END;

BEGIN
 DirectVideo:=True;
 CheckSnow:=False;
 TextColor(LightGray);
 Calibrate;
 Name;
 Open_Files(Person);
 Record_brightness;
 Inform;
 Expose;
 Close_files;
END.
```

APPENDIX C
MAIN STUDY: *PASCAL* SOURCE CODE

```
Program Homophone;

USES Crt;

VAR
  Outfile : TEXT;
  Prac, Seat,Gender  : Integer;
  Tone : String[9];
  Filename : String[32];
  Stimulus : String[22];
  Flashtime : INTEGER;
  Lang : CHAR;

CONST Sad='Sad set';
    Happy='Happy set';
    Defaultfile = 'F:\APPLIC\PSYC2\DATA\';
    Grey='   GREY AND SAD';
    Bright=' BRIGHT AND HAPPY';

Procedure Prompt;
BEGIN
   Write(' >> ');
END;

Procedure Pause;
BEGIN
 Write('Press ENTER to continue');
 Prompt;
 Readln(Stimulus);
END;

Procedure Space_left;
VAR Left : Integer;
BEGIN
 FOR Left:= 1 to 15 DO
 BEGIN
   Write(' ');
 END;
END;

Procedure Top;
VAR Top : INTEGER;
BEGIN
 FOR Top:= 1 TO 46 DO
 BEGIN
   Write(Chr(205));
 END;
END;

Procedure Middle;
VAR Mid : INTEGER;
 BEGIN
   Space_Left;
   Write(Chr(186));
   FOR Mid:= 1 TO 46 DO
   BEGIN
     Write(' ');
```

```
  END;
  Write(Chr(186));
  Writeln;
 END;

Procedure Writing;
BEGIN
 Space_left;
 Write(Chr(186));
 Write('    P S Y C H 2   P R A C T I C A L    ');
 Write(Chr(186));
 Writeln;
END;

Procedure Start;
VAR Spaces : INTEGER;
BEGIN
 ClrScr;
 FOR Spaces:= 1 TO 6 DO
 BEGIN
  Writeln;
 END;
 Space_left;
 Write (Chr(201));
 Top;
 Write(Chr(187));
 Writeln;
 FOR Spaces:= 1 TO 5 DO
 BEGIN
  Middle;
 END;
  Writing;
 FOR Spaces:= 1 TO 5 DO
 BEGIN
  Middle;
 END;
 Space_left;
 Write(Chr(200));
 Top;
 Write(Chr(188));
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Pause;
END;

Procedure Get_details (VAR Prac,Seat,Gender : Integer; VAR Lang : CHAR);
VAR Sex : CHAR;
BEGIN
   ClrScr;
   Prac:=0;
   Seat:=0;
   Gender:=500;
      Write('SCREEN 1');
      Writeln;
      Writeln;
```

```
   TextColor(Red);
   Write('Please type your P R A C');
   TextColor(LightRed+Blink);
   Write(' NUMBER');
   NormVideo;
   TextColor(Red);
   Write( ' Then press E N T E R');
   NormVideo;
   Writeln;
   REPEAT
   Prompt;
   Readln(Prac);
   UNTIL (Prac >0) AND (Prac < 241);
ClrScr;
   TextColor(Green);
   Write('SCREEN 2');
   Writeln;
   Writeln;
   Write('Please type your S E A T');
   TextColor(LightGreen+Blink);
   Write(' NUMBER');
   NormVideo;
   TextColor(Green);
   Write( ' Then press E N T E R');
   Writeln;
   NormVideo;
   Writeln;
   REPEAT
   Prompt;
   Readln(Seat);
   UNTIL (Seat >0) AND (Seat <34);
ClrScr;
   TextColor(Cyan);
   Write('SCREEN 3');
   Writeln;
   Writeln;
   Write('GENDER: IF you are MALE,   TYPE "M"');
   TextColor(LightMagenta);
   Write('        IF you are FEMALE,   TYPE "F"');
   NormVideo;
   Writeln;
   TextColor(Yellow);
   Write( 'Then press E N T E R');
   NormVideo;
   Writeln;
   REPEAT
   Prompt;
   Readln(Sex);
   UNTIL (Sex ='F') OR (Sex ='f') OR (Sex ='M') OR (Sex ='m');
   Writeln;
   IF (Sex='M') OR (Sex ='m') THEN
   BEGIN
     GENDER:=1;
   END;
   IF (Sex ='F') OR (Sex = 'f') THEN
   BEGIN
     GENDER:=2;
```

```
    END;
  ClrScr;
BEGIN
  Writeln('SCREEN 3B');
  Writeln;
  Writeln;
  Write('HOME LANGUAGE:');
  Writeln;
  Writeln('PLEASE TYPE IN THE NUMBER CORRESPONDING WITH YOUR HOME LANGUAGE');
  Writeln('              THEN PRESS "E N T E R" ');

  Writeln;
  Writeln('              ZULU 1.                 XHOSA 2.');
  Writeln('OTHER AFRICAN LANGUAGE 3.                ENGLISH 4.');
  Writeln('          AFRIKAANS 5.               OTHER 6.');
  Writeln;
  wRITELN;
  Prompt;
  Readln(Lang);
  ClrScr;
 END;
END;


Procedure Happy_sad(Seat : Integer);
BEGIN
   Tone := Happy;
   IF Frac(Seat/2) > 0 Then Tone := Sad;
END;

Procedure OPENFILE(Prac : INTEGER);
VAR
  Prac_number: String[3];
BEGIN
    Str(Prac,Prac_number);
    Filename := Concat(Defaultfile,Prac_number);
    Assign(Outfile,Filename);
    Rewrite(Outfile);
END;

Procedure Write_details(Prac,Seat,Gender : INTEGER; Tone : String; Lang : Char);
BEGIN
    Writeln(Outfile,'Subject PRAC number: ',Prac);
    Writeln(Outfile,'Subject SEAT number: ',Seat);
    Writeln(Outfile,'Subject Gender     : ',Gender);
    Writeln(Outfile,'Subject Home Lang  : ',Lang);
    Writeln(Outfile,'Tone               : ',Tone);

END;

Procedure Space;
BEGIN
    Writeln;
    Writeln;
    Writeln;
    Writeln;
    Writeln;
```

```
  Writeln;
  Writeln;
  Writeln;
  Writeln;
  Writeln;
  Writeln;
END;

Procedure Focus;
Var Shift : Integer;
BEGIN
   ClrScr;
   Space;
   FOR Shift := 1 TO 39 DO
   BEGIN
    Write(' ');
   END;
   Write(Chr(1));
   Space;
   Delay(10000);
END;

Procedure Spaceloop;
BEGIN
  Write('                          ');
END;

Procedure Flash(Stimulus : String; Flashtime : INTEGER);
BEGIN
  ClrScr;
  Space;
  Spaceloop;
  Write(Stimulus);
  Delay(Flashtime);
  ClrScr;
END;

Procedure Blank;
VAR  Block, Line : INTEGER;
BEGIN
  RANDOMIZE;
  Space;
  Spaceloop;
  For Block := 1 TO 22 DO
  BEGIN
   Write(Chr(Random(69)+176));
  END;
  Writeln;
  Delay(2500);
END;


Procedure Expose(Flashtime : INTEGER; Stimulus : String);
VAR   Loop : Integer;
BEGIN
  Stimulus := Bright;
  IF (Tone = Sad) THEN
```

```
 BEGIN
  Stimulus := Grey;
 END;
 FOR Loop:= 1 TO 15 DO
  BEGIN
   Focus;
   Flash(Stimulus, Flashtime);
   Blank;
  END;
END;

Procedure Inform;
VAR Stimulus : String[25];
   Flashtime : INTEGER;
BEGIN
 ClrScr;
 Writeln;
 Writeln;
 Writeln;
 TextColor(Green);
 FOR Flashtime:= 1 TO 4 DO
 BEGIN
  Write('                    PRAC INSTRUCTIONS    ');
  Writeln;
 END;
 Writeln;
 Writeln;
 Writeln;
 Textcolor(Red+Blink);
 Writeln;
 Write('                PLEASE  TAKE NOTE OF THE FOLLOWING');
 Delay(20000);
 Textcolor(LightGray);
 ClrScr;
 Writeln('SCREEN 4');
 Space;
 Write('     The first part of the Prac involves an experiment in PERCEPTION.');
 Writeln;
 Write(' You will see a focusing dot - a smiley face in the middle of the screen.');
 Writeln;
 Write('      Then you will see a PHRASE flashed very quickly on the screen,');
 Writeln;
 Write('        followed by random characters which will MASK the phrase.');
 Writeln;
 Write('     You need to look carefully at the focussing spot, and try your ');
 Writeln;
 Write('             best to see the phrase which follows it.');
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Pause;
 ClrScr;
 Writeln('SCREEN 5');
 Space;
 Write('This is what you will see... Wait a moment!');
 Delay(10000);
```

```
 ClrScr;
 Focus;
 Flashtime:=10000;
 Stimulus:='test phrase: LOOK HARD';
 Flash(Stimulus,Flashtime);
 Blank;
 ClrScr;
 Writeln('SCREEN 6');
 Space;
 Write('        There will be ONE PHRASE in the test, repeated 15 times.');
 Writeln;
 Write('  For each one, please watch the FOCUSSING DOT in the centre of the screen');
 Writeln;
 Write('        and try as hard as you can to see the phrase which will be ');
 Writeln;
 Write('                        flashed on the screen.');
 Writeln;
 TextColor(Blue);
 Writeln;
 Pause;
 TextColor(Lightgray);
 ClrScr;
 Writeln('SCREEN 7');
 Space;
 Write('  After the perception phase you will then be asked to wait for instructions.');
 Writeln;
 Write('   The next phase of the experiment will consist of words read out to you');
 Writeln;
 Write('      which you simply have to type in as they are read out to you.');
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Writeln('PLEASE WAIT FOR INSTRUCTION BEFORE PROCEEDING...');
 Pause;
END;

Procedure Recall;
VAR Phrase : String[20];
BEGIN
 ClrScr;
 Writeln('SCREEN 8');
 Writeln;
 TextColor(Green);
 Write('Please type out the phrase that you think was flashed on the screen');
 Writeln;
 Prompt;
 Readln(Phrase);
 Writeln(Outfile,'Subject recalled phrase: ',Phrase);
 NormVideo;
END;

Procedure Wait;
VAR Flag : String[2];
BEGIN
 TextBackground(RED);
 ClrScr;
```

```
 Writeln('SCREEN 9');
 Space;
 TextColor(Yellow);
 Writeln;
 Write('
================================================================================');
 Writeln;
 Write('          PLEASE  W A I T  FOR NEXT INSTRUCTION FROM DEMONSTRATOR');
 Writeln;
 Write('        N.B. PLEASE DO NOT TOUCH THE KEYBOARD UNTIL YOU ARE TOLD TO');
 Writeln;
 Write('
================================================================================');
 Writeln;
 REPEAT
 Readln(Flag);
 UNTIL (Flag='go') OR (Flag='GO');
 NormVideo;
 ClrScr;
END;

Procedure Spelling;
VAR Word : String[15];
   Spell : Integer;
   Flag : String[2];
   Color : Integer;
BEGIN
 Writeln('SCREEN 10');
 Space;
 Write('********************  R E C O R D I N G   P H A S E ********************');
 Writeln;
 Write('Type GO to continue');
 Prompt;
 REPEAT
 Readln(Flag);
 UNTIL (Flag='go') OR (Flag='GO');
 ClrScr;
 Color :=2;
{ Writeln('SCREEN 11');}
 FOR Spell := 1 TO 19 DO
 BEGIN
  Writeln('SCREEN ',Spell+10);
  Space;
  TextColor(Color);
  Write('Please TYPE IN word number ',Spell,' that you heard, then press E N T E R');
  Writeln;
  Prompt;
  Readln(Word);
  ClrScr;
  Writeln(Outfile,'WORD # ',Spell,' ',Word);
  Color:=Color+1;
  IF (Color >15) THEN
  BEGIN
   Color:=2;
  END;
 END;
 NormVideo;
```

```
 ClrScr;
END;

Procedure Closefiles;
BEGIN
 Close(Outfile);
END;

Procedure Thanks(Prac,Seat : Integer);
BEGIN
 Sound(2000);
 Delay(100);
 NoSound;
 Writeln('SCREEN 20');
 Space;
 TextColor(LightRed);
 Write('                    Thank you for participating.');
 Writeln;
 Write('             PLEASE WAIT TO BE DEBRIEFED BEFORE YOU GO');
 Writeln;
 TextColor(LightGreen);
 Write('                          THE END!');
 NormVideo;
 Delay(20000);
END;


{Main Program}
BEGIN
 Start;
 Get_details(Prac,Seat,Gender,Lang);
 Happy_sad(Seat);
 Openfile(Prac);
 Write_details(Prac,Seat,Gender,Tone,Lang);
 Inform;
 Flashtime:=20;
 Expose(Flashtime,Stimulus);
 Recall;
 Wait;
 Spelling;
 Closefiles;
 Thanks(Prac,Seat);
END.
```

APPENDIX D
MAIN STUDY HOMOPHONE SCORING PROGRAM (18 ITEMS): *PASCAL* SOURCE CODE

```
Program Score18;
{PROCESSES WORDS 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,17,18,19 = 11 happy, 7 sad}
USES CRT;
VAR
 Infile : TEXT;
 Outfile : TEXT;
 Prac,Seat,Gender,Home_lang,Tone,Error : INTEGER;
 word1,word2,word3,word4,word5,word6,word7,word8,word9,word10,word11,
 word12,word13,word14,word15,word16,word17,word18,word19 : INTEGER;
 H_tot,S_tot,Neutral,Errh,Errs,HNEUTRAL,SNEUTRAL : REAL;

Procedure Open_files;
BEGIN
 Assign(Infile,'c:\pilot\data\all1.txt');
 Reset (Infile);
 Assign (Outfile,'c:\new\data18n.txt');
 Rewrite(Outfile);
END;

Procedure Read_spaces;
VAR Space : INTEGER;
  Junk : Char;
BEGIN
FOR Space:= 1 TO 21 DO
 BEGIN
  Read(Infile,Junk);
 END;
END;

Procedure Word_Space1;
VAR Space : INTEGER;
  Junk : CHAR;
BEGIN
 FOR Space := 1 TO 9 DO
 BEGIN
  Read(Infile,Junk);
 END;
END;

Procedure Word_Space2;
VAR Space : INTEGER;
  Junk : CHAR;
BEGIN
 FOR Space := 1 TO 10 DO
 BEGIN
  Read(Infile,Junk);
 END;
END;

Procedure Read_data(VAR Prac,Seat,Gender,Home_lang,Tone : INTEGER;
VAR HNEUTRAL,SNEUTRAL, H_tot,S_tot,Neutral,Errh,Errs : REAL; VAR Error,
word1,word2,word3,word4,word5,word6,word7,word8,word9,word10,word11,word12,
word13,word14,word15,word16,word17,word18,word19 : INTEGER);
VAR Stuff : String[9];
  Rubbish : String[40];
  Word : String[10];
  Score : INTEGER;
```

```
  Spelling : BOOLEAN;
  WS : INTEGER;
BEGIN
 HNEUTRAL:=0;
 SNEUTRAL:=0;
 Spelling :=False;
 Tone:=1;
 Read_spaces;
 Readln(Infile,Prac);
 Read_spaces;
 Readln(Infile,Seat);
 Read_Spaces;
 Readln(Infile,Gender);
 Read_Spaces;
 Readln(Infile,Home_lang);
 Read_spaces;
 Readln(Infile,Stuff);
 IF (Stuff='Happy set') THEN
 BEGIN
  Tone:=2;
 END;
 Readln(Infile,Rubbish);
 Word_Space1;
 Readln(Infile,Word);
 Spelling :=False;
 WS:=4;
 IF (Word ='medal') OR (Word='Medal') OR (Word = 'MEDAL') THEN
 BEGIN                                    { HAPPY1}
  Spelling :=True;
  H_tot := H_tot + 1;
  WS:=1;
 END;
 IF (Word ='Meddle') OR (Word = 'meddle') OR (Word = 'MEDDLE') THEN
 BEGIN                                    {HNEUTRAL1}
  Spelling := True;
  HNeutral := HNeutral + 1;
  WS:=3;
 END;
 IF (Spelling=False) THEN
 BEGIN
  Error := error + 1;
  WS:=4;
 END;
 Word1:=WS;
 Word_Space1;
 Readln(Infile,Word);
 Spelling :=False;
 IF (Word = 'hymn') OR (Word = 'Hymn') OR (Word = 'HYMN') THEN
 BEGIN
  Spelling := True;                        {HAPPY2}
  H_tot := H_tot + 1;
  WS:=1;
 END;
 IF (Word = 'him') OR (Word = 'Him') OR (Word = 'HIM') THEN
 BEGIN                                    {HNEUTRAL2}
  Spelling := True;
  HNeutral := HNeutral + 1;
```

```
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word2:=WS;
Word_Space1;
Readln(Infile,Word);
Spelling :=False;
IF (Word = 'die') OR (Word = 'Die') OR (Word = 'DIE') THEN
BEGIN                                   {SAD1}
 Spelling :=True;
 S_tot := S_tot + 1;
 WS:=2;
END;
 IF (Word = 'dye') OR (Word = 'Dye') OR (Word = 'DYE') THEN
BEGIN
 Spelling := True;
 SNeutral := SNeutral + 1;                       {SNEUTRAL1}
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word3:=WS;
Word_Space1;
Readln(Infile,Word);
Spelling :=False;
IF (Word = 'sweet') OR (Word ='Sweet') OR (Word ='SWEET') THEN
BEGIN                                   { HAPPY3}
 Spelling := True;
 H_tot := H_tot + 1;
 WS:=1;
END;
IF (Word ='suite') OR (Word = 'Suite') OR (Word ='SUITE') THEN
BEGIN
 Spelling := True;
 HNeutral := HNeutral + 1;                       { NEUTRAL4}
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word4:=WS;
Word_Space1;
Readln(Infile,Word);
Spelling :=False;
IF (Word = 'won') OR (Word = 'Won') OR (Word = 'WON') THEN
BEGIN
 Spelling := True;                              { HAPPY3}
 H_tot := H_tot + 1;
```

```
 WS:=1;
END;
IF (Word = 'one') OR (Word = ' One') OR (Word = 'ONE') THEN
BEGIN
 Spelling := True;                    {HNEUTRAL3}
 HNeutral := HNeutral + 1;
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error:= error + 1;
 WS:=4;
END;
Word5:=WS;
Word_Space1;
Readln(Infile,Word);
Spelling :=False;
IF (Word = 'mourning') OR (Word = 'Mourning') OR (Word = 'MOURNING') THEN
BEGIN
 Spelling :=True;                     { SAD2}
 S_tot := S_tot + 1;
 WS:=2;
END;
IF (Word = 'morning') OR (Word='Morning') OR (Word='MORNING') THEN
BEGIN
 Spelling := True;                    {SNEUTRAL2}
 SNeutral := SNeutral + 1;
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word6:=WS;
Word_Space1;
Readln(Infile,Word);
Spelling :=False;
IF (Word='heal') OR (Word='Heal') OR (Word='HEAL') THEN
BEGIN
 Spelling := True;                    { HAPPY4}
 H_tot := H_tot + 1;
 WS:=1;
END;
IF (Word='heel') OR (Word='Heel') OR (Word='HEEL') THEN
BEGIN
 Spelling := True;
 HNeutral := HNeutral + 1;                 {HNEUTRAL4}
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word7:=WS;
Word_Space1;
```

```
Readln(Infile,Word);
Spelling :=False;
IF (Word='bridal') OR (Word='Bridal') OR (Word='BRIDAL') THEN
BEGIN                                   { HAPPY5}
  Spelling := True;
  H_tot := H_tot + 1;
  WS:=1;
END;
IF (Word='bridle') OR (Word='Bridle') OR (Word='BRIDLE') THEN
BEGIN
  Spelling := True;
  HNeutral := HNeutral + 1;                    {HNEUTRAL5}
  WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
  Error := error + 1;
   WS:=4;
END;
Word8:=WS;
Word_Space1;
Readln(Infile,Word);
Spelling :=False;
IF (Word='presents') OR (Word='Presents') OR (Word='PRESENTS') THEN
BEGIN
  Spelling := True;                        {HAPPY6}
  H_tot := H_tot + 1;
  WS:=1;
END;
IF (Word='presence') OR (Word='Presence') OR (Word='PRESENCE') THEN
BEGIN
  Spelling := True;
  HNeutral := HNeutral + 1;                    {HNEUTRAL6}
  WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
  Error := error + 1;
  WS:=4;
END;
Word9:=WS;
Word_Space2;
Readln(Infile,Word);
Spelling :=False;
IF (Word='banned') OR (Word='Banned') OR (Word='BANNED') THEN
BEGIN
  Spelling :=True;                         { SAD3}
  S_tot := S_tot + 1;
  WS:=2;
END;
IF (Word='band') OR (Word='Band') OR (Word='BAND') THEN
BEGIN
  Spelling := True;                        {SNEUTRAL3}
  SNeutral := SNeutral + 1;
  WS:=3;
END;
IF (Spelling=False) THEN
```

```
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word10:=WS;
Word_Space2;
Readln(Infile,Word);
Spelling :=False;
IF (Word='bored') OR (Word='Bored') OR (Word='BORED') THEN
BEGIN
 Spelling :=True;                    {SAD}
 S_tot := S_tot + 1;
 WS:=2;
END;
IF (Word='board') OR (Word='Board') OR (Word='BOARD')  THEN
BEGIN
 Spelling := True;
 SNeutral := SNeutral + 1;               {SADNEUTRAL4}
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word11:=WS;
Word_Space2;
Readln(Infile,Word);
Spelling :=False;
IF (Word='dear') OR (Word='Dear') OR (Word='DEAR') THEN
BEGIN
 Spelling := True;                   {HAPPY7}
 H_tot := H_tot + 1;
 WS:=1;
END;
IF (Word='deer') OR (Word='Deer') OR (Word='DEER') THEN
BEGIN
 Spelling := True;
 HNeutral := HNeutral + 1;               {HNEUTRAL7}
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word12:=WS;
Word_Space2;
Readln(Infile,Word);
Word13:=9;
Word_Space2;
Readln(Infile,Word);
Spelling :=False;
IF (Word='missed') OR (Word='Missed') OR (Word='MISSED') THEN
BEGIN
 Spelling :=True;                    {SAD5}
 S_tot := S_tot + 1;
```

```
 WS:=2;
END;
IF (Word='mist') OR (Word='Mist') OR (Word='MIST') THEN
BEGIN
 Spelling := True;
 SNeutral := SNeutral + 1;                    {SADNEUTRAL5}
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word14:=WS;
Word_Space2;
Readln(Infile,Word);
Spelling :=False;
IF (Word='fined') OR (Word='Fined') OR (Word='FINED') THEN
BEGIN
 Spelling :=True;
 S_tot := S_tot + 1;                  { SAD6}
 WS:=2;
END;
IF (Word='find') OR (Word='Find') OR (Word='FIND') THEN
BEGIN
 Spelling := True;
 SNeutral := SNeutral + 1;                   { SNEUTRAL6}
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word15:=WS;
Word_Space2;
Readln(Infile,Word);
Spelling :=False;
IF (Word='peace') OR (Word='Peace') OR (Word='PEACE') THEN
BEGIN
 Spelling := True;
 H_tot := H_tot + 1;                   {HAPPY8}
 WS:=1;
END;
IF (Word='piece') OR (Word='Piece') OR (Word='PIECE') THEN
BEGIN
 Spelling := True;
 HNeutral := HNeutral + 1;                    {HNEUTRAL8}
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word16:=WS;
Word_Space2;
```

```
Readln(Infile,Word);
Spelling :=False;
IF (Word='rose') OR (Word='Rose') OR (Word='ROSE') THEN
BEGIN                                    { HAPPY10}
 Spelling := True;
 H_tot := H_tot + 1;
 WS:=1;
END;
IF (Word='rows') OR (Word='Rows') OR (Word='ROWS') THEN
BEGIN
 Spelling := True;                         { NEUTRAL16}
 HNeutral := HNeutral + 1;
 WS:=3;
END;
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word17:=WS;
Word_Space2;
Readln(Infile,Word);
Spelling :=False;
IF (Word='pride') OR (Word='Pride') OR (Word='PRIDE') THEN
BEGIN
 Spelling := True;                         { HAPPY11}
 H_tot := H_tot + 1;
 WS:=1;
END;
IF (Word='pried') OR (Word='Pried') OR (Word='PRIED') THEN
BEGIN
 Spelling := True;
 HNeutral := HNeutral + 1;
 WS:=3;
END;                                     { NEUTRAL17}
IF (Spelling=False) THEN
BEGIN
 Error := error + 1;
 WS:=4;
END;
Word18:=WS;
Word_Space2;
Readln(Infile,Word);
Spelling :=False;
IF (Word='pain') OR (Word='Pain') OR (Word='PAIN') THEN
BEGIN
 Spelling :=True;                          { SAD7}
 S_tot := S_tot + 1;
 WS:=2;
END;
IF (Word='pane') OR (Word='Pane') OR (Word='PANE') THEN
BEGIN
 Spelling := True;
 SNeutral := SNeutral + 1;                     { SNEUTRAL7}
 WS:=3;
END;
IF (Spelling=False) THEN
```

```
 BEGIN
  Error := error + 1;
  WS:=4;
 END;
 Word19:=WS;
 NEUTRAL:=((HNEUTRAL/8)+(SNEUTRAL/7));
 H_tot :=(H_tot/11);
 S_tot:=(S_tot/7);
 HNEUTRAL := HNEUTRAL/11;
 SNEUTRAL := SNEUTRAL/7;
 Errh := ABS(1-(H_tot+HNEUTRAL));
 Errs := ABS(1-(S_tot+SNEUTRAL));
END;


Procedure Output(Prac,Seat,Gender,Home_lang,Tone : INTEGER;
H_tot,S_tot,Neutral,Errh,Errs : REAL; Error,word1,word2,word3,word4,word5,
word6,word7,word8,word9,word10,word11,word12,word13,word14,word15,word16,
word17,word18,word19 : INTEGER; HNEUTRAL,SNEUTRAL : REAL);
BEGIN
 Write(Outfile,Prac:3);
 Write(Outfile,' ');
 Write(Outfile,Seat:2);
 Write(Outfile,' ');
 Write(Outfile,Gender);
 Write(Outfile,' ');
 Write(Outfile,Home_lang);
 Write(Outfile,' ');
 Write(Outfile,Tone);
 Write(Outfile,' ');
 Write(Outfile,H_tot:2:2);
 Write(Outfile,' ');
 Write(Outfile,S_tot:2:2);
 Write(Outfile,' ');
 Write(Outfile,Neutral:2:2);
 Write(Outfile,' ');
 Write(Outfile,HNEUTRAL:2:2);
 Write(Outfile,' ');
 Write(Outfile,SNEUTRAL:2:2);
 Write(Outfile,' ');
 Write(Outfile,Error:2);
 Write(Outfile,' ');
 Write(Outfile,word1,word2,word3,word4,word5,word6,word7,word8,word9,word10,
 word11, word12,word13,word14,word15,word16,word17,word18,word19);
 Write(Outfile,' ');
 Write(Outfile,Errh:2:2);
 Write(Outfile,' ');
 Write(Outfile,Errs:2:2);
 Writeln(Outfile);
END;

Procedure Close_Files;
BEGIN
 Close(Infile);
 Close(Outfile);
END;
```

```
BEGIN
 Open_Files;
 Writeln(Outfile,'BEGIN DATA');
 WHILE NOT EOF(Infile) DO
 BEGIN
  word1:=9;
  word2:=9;
  word3:=9;
  word4:=9;
  word5:=9;
  word6:=9;
  word7:=9;
  word8:=9;
  word9:=9;
  word10:=9;
  word11:=9;
  word12:=9;
  word13:=9;
  word14:=9;
  word15:=9;
  word16:=9;
  word17:=9;
  word18:=9;
  word19:=9;
  H_tot :=0;
  S_tot:=0;
  Neutral :=0;
  Error :=0;
  Errh:=0;
  Errs:=0;
  Read_data(Prac,Seat,Gender,Home_lang,Tone,HNEUTRAL,SNEUTRAL,H_tot,S_tot,
Neutral,Errh,Errs,Error,word1,word2,word3,word4,word5,word6,word7,word8,word9,
  word10, word11,word12,word13,word14,word15,word16,word17,word18,word19);
  Output(Prac,Seat,Gender,Home_lang,Tone,H_tot,S_tot,Neutral,Errh,Errs,
  Error,word1,word2,word3,word4,word5,word6,word7,word8,word9,word10,
  word11,word12,word13,word14,word15,word16,word17,word18,
  word19,HNEUTRAL,SNEUTRAL);
 END;
 Writeln(Outfile,'END DATA.');
 Close_Files;
END.
```

APPENDIX D
FOLLOW UP STUDY:
PASCAL SOURCE CODE

```
Program Followup;

USES Crt;

TYPE ROW = ARRAY[1..22] OF INTEGER;

VAR
   Outfile : TEXT;
   Infile: TEXT;
   Prac, Gender  : Integer;
   Tone : Integer;
   Name : String[25];
   Filename : String[32];
   Stimulus : String[22];
   Flashtime : INTEGER;
   Lang : INTEGER;
   R : ROW;

CONST Sad='Sad set';
     Happy='Happy set';
     Defaultfile = 'c:\pilot\';
     Grey=  '     SAD AND ALONE';
     Bright= '  HAPPY AND FRIENDLY';
     Infile_name = 'c:\pilot\quest.txt';

Procedure Prompt;

BEGIN
    Write(' >> ');
END;

Procedure Pause;
BEGIN
  Write('Press ENTER to continue');
  Prompt;
  Readln(Stimulus);
END;

Procedure Space_left;
VAR Left : Integer;
BEGIN
  FOR Left:= 1 to 15 DO
  BEGIN
    Write(' ');
  END;
END;

Procedure Top;
VAR Top : INTEGER;
BEGIN
  FOR Top:= 1 TO 46 DO
  BEGIN
    Write(Chr(205));
  END;
END;

Procedure Middle;
```

```
VAR Mid : INTEGER;
 BEGIN
  Space_Left;
  Write(Chr(186));
  FOR Mid:= 1 TO 46 DO
  BEGIN
   Write(' ');
  END;
  Write(Chr(186));
  Writeln;
 END;

Procedure Writing;
BEGIN
 Space_left;
 Write(Chr(186));
 Write('     P S Y C H 2    F O L L O W U P      ');
 Write(Chr(186));
 Writeln;
END;

Procedure Start;
VAR Spaces : INTEGER;
BEGIN
 ClrScr;
 FOR Spaces:= 1 TO 6 DO
 BEGIN
  Writeln;
 END;
 Space_left;
 Write (Chr(201));
 Top;
 Write(Chr(187));
 Writeln;
 FOR Spaces:= 1 TO 5 DO
 BEGIN
  Middle;
 END;
  Writing;
 FOR Spaces:= 1 TO 5 DO
 BEGIN
  Middle;
 END;
 Space_left;
 Write(Chr(200));
 Top;
 Write(Chr(188));
 Writeln;
 Writeln;
 Writeln;
 Writeln;
 Pause;
END;

Procedure Get_details (VAR Prac : INTEGER; VAR Gender : Integer;
VAR Lang : INTEGER);
VAR Sex : CHAR;  code: Integer; Language : String[2];
```

```
BEGIN
  ClrScr;
  Prac:=0;
  Gender:=500;
    REPEAT
    Writeln;
    Writeln;
    TextColor(Red);
    Write('Please type your P R A C');
    TextColor(LightRed+Blink);
    Write(' NUMBER');
    NormVideo;
    TextColor(Red);
    Write( ' Then press E N T E R');
    NormVideo;
    Writeln;
    Prompt;
    Readln(Prac);
    ClrScr;
    UNTIL (Prac >0) AND (Prac < 241);
  ClrScr;
    TextColor(Green);
    Writeln;
    Writeln;
    Write('Please type in your');
    TextColor(LightGreen+Blink);
    Write(' N A M E');
    NormVideo;
    TextColor(Green);
    Write( ' Then press E N T E R');
    Writeln;
    NormVideo;
    Writeln;
    Prompt;
    Readln(Name);
  ClrScr;
    TextColor(Cyan);
    Writeln;
    Writeln;
    Write('GENDER: IF you are MALE,   TYPE "M"');
    TextColor(LightMagenta);
    Write('        IF you are FEMALE,   TYPE "F"');
    NormVideo;
    Writeln;
    Writeln;
    TextColor(Yellow);
    Write( 'Then press E N T E R');
    NormVideo;
    Writeln;
    REPEAT
    Prompt;
    Readln(Sex);
    UNTIL (Sex ='F') OR (Sex ='f') OR (Sex ='M') OR (Sex ='m');
    Writeln;
    IF (Sex='M') OR (Sex ='m') THEN
    BEGIN
      GENDER:=1;
```

```
        END;
        IF (Sex ='F') OR (Sex = 'f') THEN
        BEGIN
          GENDER:=2;
        END;
     ClrScr;
  BEGIN
   REPEAT
   Writeln;
   Writeln;
   Write('HOME LANGUAGE:');
   Writeln;
   Writeln;
   Writeln('PLEASE TYPE IN THE NUMBER CORRESPONDING WITH YOUR HOME LANGUAGE');
   Writeln('              THEN PRESS "E N T E R" ');
   Writeln;
   Writeln('              ZULU 1.                   XHOSA 2.');
   Writeln('OTHER AFRICAN LANGUAGE 3.              ENGLISH 4.');
   Writeln('          AFRIKAANS 5.                 OTHER 6.');
   Writeln;
   WRITELN;
   Prompt;
   Readln(Language);
   Val(Language, Lang, code);
   { Error during conversion to Integer? }
   ClrScr;
   UNTIL ((Code=0) AND (Lang<7) AND (Lang>0));
  END;
END;


Procedure Happy_sad(VAR Tone : INTEGER);
VAR RAND : REAL;
   Loop : INTEGER;
   Out :Text;

BEGIN
                         {   Assign(out,'c:\pilot\Randfile');
                             Rewrite(out);}
   Randomize;
                          {   FOR Loop :=1 TO 1000 DO
                              BEGIN}
   Rand := Int((Random(1000))+1);
   Tone := 2;
   IF Frac(Rand/2) > 0 Then Tone := 1;
                           {   Writeln(Out,Tone);
                               END;
                               Close(Out);      }
END;

Procedure OPENFILE(Prac : INTEGER);
VAR
  Prac_number: String[3];
BEGIN
    Str(Prac,Prac_number);
    Filename := Concat(Defaultfile,Prac_number);
    Assign(Outfile,Filename);
```

```
  Rewrite(Outfile);
END;

Procedure Open_questions;
BEGIN
 Assign(Infile,Infile_name);
 Reset(Infile);
END;

Procedure Close_questions;
BEGIN
 Close(Infile);
END;

Procedure Write_details(Prac:INTEGER; Name: String; Gender : INTEGER;
Lang,Tone : INTEGER);
BEGIN
   Write(Outfile,Prac:3,' ',Name:25,' ',Gender, Lang,Tone,' ');
END;

Procedure Space;
BEGIN
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
END;

Procedure Space2;
BEGIN
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
   Writeln;
END;

{==============================GHQ==================================}

Procedure Have_you;
BEGIN
 TextColor(White);
 Writeln('HAVE YOU RECENTLY:');
 NormVideo;
 Writeln;
```

```
END;

Procedure Scale;
BEGIN
  TextColor(Cyan);
   Write('TYPE "1"');
  TextColor(Lightgreen);
         Write('       TYPE "2"');
  TextColor(Yellow);
                    Write('    TYPE "3"');
  TextColor(LightMagenta);
                           Write('      TYPE "4"');
  NormVideo;
  Writeln;
  Writeln;
  Writeln;
END;

Procedure Question1(Var Q1 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('1. Been able to concentrate on whatever you`re doing?');
  NormVideo;
  Writeln;
  Writeln('BETTER THAN      SAME AS      LESS THAN      MUCH LESS THAN');
  Writeln('USUAL            USUAL        USUAL          USUAL');
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer, Q1, code);
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (Q1<5) AND (Q1>0));
END;

Procedure Question2(Var Q2 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('2. Lost much sleep over worry?');
  NormVideo;
  Writeln;
  Writeln('NOT AT        NO MORE      RATHER MORE    MUCH MORE');
  Writeln('ALL         THAN USUAL   THAN USUAL     THAN USUAL');
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer, Q2, code);
```

```
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (Q2<5) AND (Q2>0));
END;

Procedure Question3(Var Q3 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('3. Felt that you are playing a useful part in things?');
  NormVideo;
  Writeln;
  Writeln('MORE SO        SAME AS     LESS USEFUL    MUCH LESS');
  Writeln('THAN USUAL      USUAL       THAN USUAL    USEFUL   ');
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer, Q3, code);
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (Q3<5) AND (Q3>0));
END;

Procedure Question4(Var Q4 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('4. Felt capable of making decisions about things?');
  NormVideo;
  Writeln;
  Writeln('MORE SO        SAME AS     LESS SO      MUCH LESS');
  Writeln('THAN USUAL      USUAL       THAN USUAL    CAPABLE  ');
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer, Q4, code);
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (Q4<5) AND (Q4>0));
END;

Procedure Question5(Var Q5 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
```

```
 Writeln('6. Felt constantly under strain?');
 NormVideo;
 Writeln;
 Writeln('NOT AT        NO MORE     RATHER MORE   MUCH MORE');
 Writeln('ALL          THAN USUAL   THAN USUAL    THAN USUAL');
 Scale;
 Prompt;
 Readln(Answer);
 Val(Answer, Q5, code);
 { Error during conversion to Integer? }
 ClrScr;
 UNTIL ((Code=0) AND (Q5<5) AND (Q5>0));
END;

Procedure Question6(Var Q6 : INTEGER);
VAR Answer : String[2];
  Code : Integer;
BEGIN
 REPEAT
 Space;
 Have_you;
 TextBackground(Blue);
 Writeln('7. Felt that you couldn`t overcome your difficulties?');
 NormVideo;
 Writeln;
 Writeln('NOT AT        NO MORE     RATHER MORE   MUCH MORE');
 Writeln('ALL          THAN USUAL   THAN USUAL    THAN USUAL');
 Scale;
 Prompt;
 Readln(Answer);
 Val(Answer,Q6, code);
 { Error during conversion to Integer? }
 ClrScr;
 UNTIL ((Code=0) AND (Q6<5) AND (Q6>0));
END;

Procedure Question7(Var Q7 : INTEGER);
VAR Answer : String[2];
  Code : Integer;
BEGIN
 REPEAT
 Space;
 Have_you;
 TextBackground(Blue);
 Writeln('8. Been able to enjoy your normal day-to-day activities?');
 NormVideo;
 Writeln;
 Writeln('MORE SO      SAME AS     LESS SO      MUCH LESS');
 Writeln('THAN USUAL     USUAL      THAN USUAL    THAN USUAL');
 Scale;
 Prompt;
 Readln(Answer);
 Val(Answer,Q7, code);
 { Error during conversion to Integer? }
 ClrScr;
 UNTIL ((Code=0) AND (Q7<5) AND (Q7>0));
END;
```

```
Procedure Question8(Var Q8 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('9. Been able to face up to your problems?');
  NormVideo;
  Writeln;
  Writeln('MORE SO        SAME AS     LESS ABLE     MUCH LESS');
  Writeln('THAN USUAL       USUAL       THAN USUAL     ABLE       ');
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer,Q8, code);
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (Q8<5) AND (Q8>0));
END;

Procedure Question9(Var Q9 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('10. Been feeling unhappy and depressed?');
  NormVideo;
  Writeln;
  Writeln('NOT AT         NO MORE     RATHER MORE    MUCH MORE');
  Writeln('ALL          THAN USUAL   THAN USUAL     THAN USUAL');
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer,Q9, code);
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (Q9<5) AND (Q9>0));
END;

Procedure Question10(Var Q10 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('11. Been losing confidence in yourself?');
  NormVideo;
  Writeln;
  Writeln('NOT AT         NO MORE     RATHER MORE    MUCH MORE');
  Writeln('ALL          THAN USUAL   THAN USUAL     THAN USUAL');
```

```
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer,Q10, code);
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (Q10<5) AND (Q10>0));
END;

Procedure Question11(Var Q11 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('13. Been thinking of yourself as a worthless person?');
  NormVideo;
  Writeln;
  Writeln('NOT AT        NO MORE      RATHER MORE    MUCH MORE');
  Writeln('ALL         THAN USUAL   THAN USUAL     THAN USUAL');
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer,Q11, code);
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (Q11<5) AND (Q11>0));
END;

Procedure Validity1(VAR V1 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('5. Been thinking of yourself as a particularly brilliant person?');
  NormVideo;
  Writeln;
  Writeln('NOT AT        NO MORE      RATHER MORE    MUCH MORE');
  Writeln('ALL         THAN USUAL   THAN USUAL     THAN USUAL');
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer,V1, code);
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (V1<5) AND (V1>0));
END;

Procedure Validity2(VAR V2 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
```

```
 REPEAT
 Space;
 Have_you;
 TextBackground(Blue);
 Writeln('12. Had your picture on the cover of an international magazine?');
 NormVideo;
 Writeln;
 Writeln('NOT AT         NO MORE      RATHER MORE    MUCH MORE');
 Writeln('ALL          THAN USUAL   THAN USUAL     THAN USUAL');
 Scale;
 Prompt;
 Readln(Answer);
 Val(Answer,V2, code);
 { Error during conversion to Integer? }
 ClrScr;
 UNTIL ((Code=0) AND (V2<5) AND (V2>0));
END;

Procedure Question12(Var Q12 : INTEGER);
VAR Answer : String[2];
   Code : Integer;
BEGIN
  REPEAT
  Space;
  Have_you;
  TextBackground(Blue);
  Writeln('14. Been feeling reasonably happy, all things considered?');
  NormVideo;
  Writeln;
  Writeln('MORE SO         ABOUT SAME   LESS SO       MUCH LESS');
  Writeln('THAN USUAL       AS USUAL    THAN USUAL     THAN USUAL');
  Scale;
  Prompt;
  Readln(Answer);
  Val(Answer,Q12, code);
  { Error during conversion to Integer? }
  ClrScr;
  UNTIL ((Code=0) AND (Q12<5) AND (Q12>0));
END;

Procedure Score(Question : INTEGER; VAR L_Score, G_Score : INTEGER);
BEGIN
  CASE Question OF
    2 : L_Score:=L_Score+1;
    3 : L_Score:=L_Score+2;
    4 : L_Score:=L_Score+3;
  END;
  CASE Question OF
    3 : G_Score:=G_Score+1;
    4 : G_Score:=G_Score+1;
  END;
END;

Procedure ScoreV(V : INTEGER);
BEGIN
  V:=0;
  CASE V OF
```

```
    2 : V:=V+1;
    3 : V:=V+2;
    4 : V:=V+3;
  END;
END;

Procedure Intro;
BEGIN
  Writeln('==========================================================================');
  Writeln('          GENERAL HEALTH QUESTIONNAIRE : DAVID P. GOLDBERG');
  Writeln('              London: Oxford University Press 1972');
  Writeln('==========================================================================');
  Writeln;
  Writeln;
  Writeln;
  Writeln('Please read this carefully:');
  Writeln;
  Writeln('We should like to know if you have had any health complaints, and how your');
  Write('health has been in general, ');
  TextBackground(Blue);
  Write('OVER THE LAST FEW WEEKS.');
  NormVideo;
  Writeln(' You will be asked a');
  Writeln('series of questions - please answer them ALL. You should respond by looking');
  Writeln('carefully at the options presented with each question. Once you have decided');
  Writeln('which of the options most nearly applies to you, please type the number');
  Writeln('underneath the option and then press the "E N T E R" key.');
  Writeln;
  Writeln('Remember that we want to know about present and recent complaints, not');
  Writeln('those that you had in the past.');
  Writeln;
  Writeln('It is important that you try to answer ALL the questions.');
  Writeln;
  Writeln('Thank you very much for your cooperation');
  Writeln;
  Pause;
  ClrScr;
END;

Procedure Ghq;
VAR V1,V2,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,Q11,Q12,L_score,G_score, Valid : INTEGER;
BEGIN
  L_Score:=0;
  G_Score:=0;
  V1 :=0;
  V2 :=0;
  ClrScr;
  Intro;
  Question1(Q1);
  Score(Q1,L_Score,G_score);
  Write(Outfile,Q1);
  Question2(Q2);
  Score(Q2,L_Score,G_score);
  Write(Outfile,Q2);
  Question3(Q3);
  Score(Q3,L_Score,G_score);
  Write(Outfile,Q3);
```

```
Question4(Q4);
Score(Q4,L_Score,G_score);
Write(Outfile,Q4);
Validity1(V1);
ScoreV(V1);
Question5(Q5);
Score(Q5,L_Score,G_score);
Write(Outfile,Q5);
Question6(Q6);
Score(Q6,L_Score,G_score);
Write(Outfile,Q6);
Question7(Q7);
Score(Q7,L_Score,G_score);
Write(Outfile,Q7);
Question8(Q8);
Score(Q8,L_Score,G_score);
Write(Outfile,Q8);
Question9(Q9);
Score(Q9,L_Score,G_score);
Write(Outfile,Q9);
Question10(Q10);
Score(Q10,L_Score,G_score);
Write(Outfile,Q10);
Validity2(V2);
ScoreV(V2);
Question11(Q11);
Score(Q11,L_Score,G_score);
Write(Outfile,Q11);
Question12(Q12);
Score(Q12,L_Score,G_score);
Write(Outfile,Q12);
Valid:=V1+V2;
Write(Outfile,G_Score:2,L_Score:2,V1,V2,Valid);
END;
{══════════════════════GHQ══════════════════════════}

{XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXPOMSXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXX}
Procedure Header;
BEGIN

Writeln('══════════════════════════════════════════════════
═════');
 Writeln('                    P O M S');

Writeln('══════════════════════════════════════════════════
═════');
 Writeln;
 Writeln;
 Writeln('This word is part of a list of words that describe feelings that people have.');
 Writeln('PLEASE READ EACH ONE CAREFULLY.');
 Writeln('There are options and numbers presented with each word. Please select one of');
 Write('the options that best describes ');
 TextBackground(Blue);
 Writeln('HOW YOU ARE FEELING AT THIS PRESENT MOMENT,');
 NormVideo;
 Writeln('- I.E. RIGHT NOW! Please type the number underneath the option and then');
```

```
 Writeln('press the "E N T E R" key.');
 Writeln;
 Writeln;
END;

Procedure Page;
BEGIN
  Writeln(' NOT AT ALL       A LITTLE      MODERATELY  QUITE A BIT     EXTREMELY');
  TextColor(LightMagenta);
   Write('   TYPE "0"');
  TextColor(Lightgreen);
        Write('        TYPE "1"');
  TextColor(Yellow);
                 Write('       TYPE "2"');
  TextColor(Cyan);
                       Write('    TYPE "3"');
  TextColor(Green);
                              Write('      "TYPE 4"');
  NormVideo;
  Writeln;
  Writeln;
  Writeln;
END;

Procedure Poms;
TYPE
 Questions = ARRAY[1..65] OF STRING[26];
 Answers = ARRAY[1..65] OF INTEGER;

VAR
 Q : Questions;
 A : Answers;
 Index,Code : INTEGER;
 Answertxt : String[2];
 T,D,AN,V,F,C,TMD : INTEGER;

BEGIN
 Open_questions;
 FOR Index := 1 TO 65 DO
 BEGIN
  Readln(Infile,Q[Index]);
  A[Index] :=0;
  REPEAT
   ClrScr;
   Header;
   TextBackground(Red);
   Writeln('(',Index,')   ',Q[Index]);
   NormVideo;
   Writeln;
   Writeln;
   Page;
   Prompt;
   Readln(Answertxt);
   Val(Answertxt,A[Index], code);
   { Error during conversion to Integer? }
   ClrScr;
  UNTIL ((Code=0) AND (A[Index]<5));
```

```
 END;
 T:=A[2]+A[10]+A[16]+A[20]-A[22]+A[26]+A[27]+A[34]+A[41];
 D:=A[5]+A[9]+A[14]+A[18]+A[21]+A[23]+A[32]+A[35]+A[36]+A[44]+A[45]+A[48]
   +A[58]+A[61]+A[62];
 AN:=A[3]+A[12]+A[17]+A[24]+A[31]+A[33]+A[39]+A[42]+A[47]+A[52]+A[53]+A[57];
 V:=A[7]+A[15]+A[19]+A[38]+A[51]+A[56]+A[60]+A[63];
 F:=A[4]+A[11]+A[29]+A[40]+A[46]+A[49]+A[65];
 C:=A[8]+A[28]+A[37]+A[50]-A[54]+A[59]+A[64];
 TMD:=(T+D+AN+F+C)-V;
 Write(Outfile,'T',T:2,'D',D:2,'A',AN:2,'V',V:2,'F',F:2,'C',C:2,'TMD',TMD:3);
 Writeln(Outfile);
 For Index:= 1 To 65 Do
 BEGIN
  Write(Outfile,A[Index]);
 END;
 Close_questions;
END;

{xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxEND OF POMSxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx}
Procedure Focus;
Var Shift : Integer;
BEGIN
   ClrScr;
   Space;
   FOR Shift := 1 TO 39 DO
   BEGIN
     Write(' ');
   END;
   Write(Chr(1));
   Space;
   Delay(10000);
END;

Procedure Spaceloop;
BEGIN
 Write('                    ');
END;

Procedure Flash(Stimulus : String; Flashtime : INTEGER);
BEGIN
 ClrScr;
 Space;
 Spaceloop;
 TextColor(White);
 Write(Stimulus);
 NormVideo;
 Delay(Flashtime);
 ClrScr;
END;

Procedure Blank;
VAR
 Ro : INTEGER;
BEGIN
 Space;
 Spaceloop;
 FOR Ro:= 1 To 22 DO
```

```
 BEGIN
  Write(Chr(R[Ro]));
 END;
 Delay(2500);
END;

Procedure Create;
VAR
 Ro: INTEGER;
BEGIN
 RANDOMIZE;
 FOR Ro:= 1 To 22 DO
 BEGIN
  R[Ro]:=(Random(9)+232); {old =69+176 new=14+224}
 END;
END;


Procedure Expose(Flashtime : INTEGER; Stimulus : String);
VAR   Loop : Integer;
BEGIN
 Stimulus := Bright;
 IF (Tone = 1) THEN
 BEGIN
  Stimulus := Grey;
 END;
 FOR Loop:= 1 TO 15 DO
  BEGIN
   Create;
   Focus;
   Flash(Stimulus, Flashtime);
   Blank;
  END;
END;

Procedure Inform;
VAR Stimulus : String[25];
  Flashtime : INTEGER;
BEGIN
 ClrScr;
 Writeln;
 Writeln;
 Writeln;
 TextColor(Green);
 FOR Flashtime:= 1 TO 4 DO
 BEGIN
  Write('                    TASK INSTRUCTIONS    ');
  Writeln;
 END;
 Writeln;
 Writeln;
 Writeln;
 Textcolor(Red);
 Writeln;
 Write('              PLEASE  TAKE NOTE OF THE FOLLOWING');
 Delay(15000);
 Textcolor(LightGray);
```

```
  ClrScr;
  Space;
  Write('     The first part of the task involves an experiment in PERCEPTION.');
  Writeln;
  Writeln(' You will see a focusing dot - a tiny face in the middle of the screen.');
  Write('      Then you will see a PHRASE flashed very quickly on the screen,');
  Writeln;
  Write('        followed by random characters which will MASK the phrase.');
  Writeln;
  Write('     You need to look carefully at the focussing spot, and try your ');
  Writeln;
  Write('              best to see the phrase which follows it.');
  Writeln;
  Writeln;
  Writeln;
  Writeln;
  Pause;
  ClrScr;
  Space;
  Write('This is what you will see... Wait a moment!');
  Delay(10000);
  ClrScr;
  Focus;
  Flashtime:=10000;
  Create;
  Stimulus:='test phrase: LOOK HARD';
  Flash(Stimulus,Flashtime);
  Blank;
  ClrScr;
  Space;
  Write('        There will be ONE PHRASE in the test, repeated 15 times.');
  Writeln;
  Write(' For each one, please watch the FOCUSSING DOT in the centre of the screen');
  Writeln;
  Write('        and try as hard as you can to see the phrase which will be ');
  Writeln;
  Write('                      flashed on the screen.');
  Writeln;
  TextColor(Blue);
  Writeln;
  Pause;
  TextColor(Lightgray);
  ClrScr;
  Writeln('PLEASE WAIT FOR INSTRUCTION BEFORE PROCEEDING...');
  Pause;
END;

Procedure Recall;
VAR Phrase : String[22];
BEGIN
  ClrScr;
  Writeln;
  TextColor(Green);
  Write('Please type out the phrase that you think was flashed on the screen');
  Writeln;
  Prompt;
  Readln(Phrase);
```

```
 Writeln(Outfile);
 Write(Outfile,Phrase:22);
 Write(Outfile,'                    ');
 NormVideo;
 ClrScr;
END;

Procedure Closefiles;
BEGIN
 Close(Outfile);
END;

Procedure Thanks;
VAR Flag : String[2];
   Group, Words : INTEGER;
BEGIN
 Sound(2000);
 Delay(100);
 NoSound;
 Space;
 TextColor(LightRed);
 Write('                  Thank you for participating.');
 Writeln;
 Write('              PLEASE WAIT TO BE DEBRIEFED BEFORE YOU GO');
 Writeln;
 TextColor(LightGreen);
 Writeln('                         THE END!');
 NormVideo;
 REPEAT
 Prompt;
 Readln(Flag);
 UNTIL (Flag='go') OR (Flag ='GO');
 NormVideo;
 ClrScr;
 Writeln('ENTER GROUP CLUSTER NUMBER');
 Prompt;
 Readln(Group);
 Writeln('ENTER NUMBER OF WORDS RECOGNISED');
 Prompt;
 Readln(Words);
 Write(Outfile,'   ',Group:1,' ',Words);
END;

Procedure Poms2_intro;
BEGIN
 Space;
 Writeln('You will be asked again to do the "POMS" questions. Please answer according');
 Writeln('to how you feel at this point in time.');
 Writeln;
 Pause;
END;


{Main Program}
BEGIN
 Start;
 Get_details(Prac,Gender,Lang);
```

```
 Happy_sad(Tone);
 Openfile(Prac);
 Write_details(Prac,Name,Gender,Lang,Tone);
 Ghq;
 Poms;
 Inform;
 Flashtime:=20;
 Expose(Flashtime,Stimulus);
 Recall;
 Poms2_intro;
 Poms;
 Thanks;
 Closefiles;
END.
```

APPENDIX E
FOLLOW UP STUDY: BOOTSTRAP ALGORITHM
ESTIMATION OF *t* FOR 'SAD' GROUP (*n*=11) USING DIFFERENCE SCORES
PASCAL SOURCE CODE

```
Program bootstrap_T;
{does N iterations to calculate T for one sample based on difference values
pre/post. Sad Group}

USES CRT;

TYPE
DIFFERENCES = Array[1..11] OF REAL; {Input file of difference values}
D_SQUARED = Array[1..11] OF REAL; {array of DIFFERENCES squared}
SAMPLE = Array[1..11] OF REAL; {generated sample}

VAR
 Infile : TEXT;
 Outfile : TEXT;
 DIFF : DIFFERENCES;
 D2 : D_SQUARED;
 S1 : SAMPLE;
 D_loop: INTEGER;
 Dsq, Diff_mean,Sumd2,T,Sums_squares,T_total,Count,T_average,N : REAL;
 Input,Output : String[25];
 Name : String[10];
 FLAG : Boolean;

CONST
 Diff_no = 11;

PROCEDURE Filenames(VAR FLAG: Boolean);
VAR Y : String[1];
BEGIN
 ClrScr;
 Write('INPUT FILE NAME - MAX 25 CHARACTERS >> ');
 Readln(Input);
 Write('OUTPUT FILE NAME - MAX 25 CHARACTERS >> ');
 Readln(Output);
 Write('INPUT VARIABLE NAME >> ');
 Readln(Name);
 Write('DO YOU WISH TO OUTPUT ACTUAL STATISTICS? Y/N >>');
 Readln(Y);
 IF (Y='Y') OR (Y='y') THEN
 BEGIN
  FLAG:=True;
 END;
END;

PROCEDURE Open_Files;
BEGIN
 Assign(Infile,Input);
 Reset(Infile);
 Assign(Outfile,Output);
 Rewrite(Outfile);
END;

PROCEDURE Close_files;
BEGIN
 Close(Infile);
 Close(Outfile);
END;
```

```
Procedure Iterations(VAR N: REAL);
BEGIN
 Write('INPUT ITERATIONS>> ');
 Readln(N);
END;

Procedure Read_data;
BEGIN
 FOR D_loop := 1 TO Diff_no DO
 BEGIN
   Readln(Infile,DIFF[D_loop]);
 END;
END;

{This procedure calculates Dsquared}
Procedure Calc_dsquared(VAR Dsq : REAL);
BEGIN
 Dsq:=0;
 FOR D_Loop := 1 TO DIFF_NO DO
 BEGIN
   D2[D_loop]:=(Diff[D_loop]*Diff[D_loop]);
   Dsq:=Dsq + D2[D_Loop];
 END;
END;

{This procedure calculates the mean of the differences - i.e. just the mean}
{of the input values which are difference values}

Procedure Calc_diff_mean( VAR Diff_mean,Total : REAL);
BEGIN
 Total:=0;
 Diff_mean :=0;
 FOR D_Loop := 1 TO Diff_no DO
 BEGIN
   Total:=Total + DIFF[D_loop];
 END;
 Diff_mean := Total/Diff_no;
END;

{This procedure calculates the (sum of d)squared /N}
Procedure Calc_sumd2(VAR sumd2 : REAL; Total : Real);
BEGIN
 Sumd2 := (Total*Total);
END;

{N.B. This procedure calculates the first T value only!!!!}
Procedure Calc_first_T(VAR T: REAL);
VAR Total : REAL;
BEGIN
 Calc_dsquared(Dsq);
 Calc_diff_mean(Diff_mean, Total);
 Calc_sumd2(sumd2, Total);
 Sums_squares := Dsq-(Sumd2/Diff_no);
 T:= Diff_mean/(Sqrt(Sums_squares/(Diff_no*(Diff_no-1))));
END;

Procedure Random_sample;
```

```
VAR R: INTEGER;
BEGIN
 FOR D_Loop := 1 TO Diff_no DO
 BEGIN
  R:=(Trunc(Random*Diff_no)+1);
  S1[D_loop]:=Diff[R];
 END;
END;

{+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}
{ ALL PROCEDURES NOW USE ARRAY S1 WHICH IS A RANDOM SAMPLE FROM THE ORIGINAL }
{+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}

{This procedure calculates Dsquared}
Procedure Calc_dsquaredS1(VAR Dsq : REAL);
BEGIN
 Dsq:=0;
 FOR D_Loop := 1 TO DIFF_NO DO
 BEGIN
  D2[D_loop]:=(S1[D_loop]*S1[D_loop]);
  Dsq:=Dsq + D2[D_Loop];
 END;
END;

{This procedure calculates the mean of the differences - i.e. just the mean}
{of the input values which are difference values}

Procedure Calc_diff_meanS1( VAR Diff_mean,Total : REAL);
BEGIN
 Total:=0;
 Diff_mean :=0;
 FOR D_Loop := 1 TO Diff_no DO
 BEGIN
  Total:=Total + S1[D_loop];
 END;
 Diff_mean := Total/Diff_no;
END;

{This procedure calculates the (sum of d)squared /N}
Procedure Calc_sumd2S1(VAR sumd2 : REAL; Total : Real);
BEGIN
 Sumd2 := (Total*Total);
END;

{N.B. This procedure calculates the T value from the random sample}
Procedure Calc_Sample_T(VAR T: REAL);
VAR Total : REAL;
BEGIN
 Random_sample;
 Calc_dsquaredS1(Dsq);
 Calc_diff_meanS1(Diff_mean, Total);
 Calc_sumd2S1(sumd2, Total);
 Sums_squares := Dsq-(Sumd2/Diff_no);
 T:= Diff_mean/(Sqrt(Sums_squares/(Diff_no*(Diff_no-1))));
END;

{+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}
```

```
{++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}

Procedure WriteT(T: REAL);
BEGIN
 Writeln(Outfile,T:8:5);
END;

Procedure Report1(T: REAL);
BEGIN
 Write(Outfile,'T STATISTIC FOR THE PRE/POST DIFFERENCE FOR THE ');
 Write(Outfile,'VARIABLE ~',Name,'~: ',T:8:5);
 Writeln(Outfile);
END;

Procedure Report2(Count,T_average: REAL);
BEGIN
 Write(Outfile,'Bootstrap estimate of T for ',Count:15:0,' iterations: ');
 Writeln(Outfile,T_average:12:7);
END;

Procedure Progress(Count,N : REAL);
BEGIN
 IF (Count =(N/10)) THEN
 BEGIN
  Write('10% ');
 END;
 IF (Count =(2*(N/10))) THEN
 BEGIN
  Write('20% ');
 END;
 IF (Count =(3*(N/10))) THEN
 BEGIN
  Write('30% ');
 END;
 IF (Count =(4*(N/10))) THEN
 BEGIN
  Write('40% ');
 END;
 IF (Count =(5*(N/10))) THEN
 BEGIN
  Write('50% ');
 END;
 IF (Count =(6*(N/10))) THEN
 BEGIN
  Write('60% ');
 END;
 IF (Count =(7*(N/10))) THEN
 BEGIN
  Write('70% ');
 END;
 IF (Count =(8*(N/10))) THEN
 BEGIN
  Write('80% ');
 END;
 IF (Count =(9*(N/10))) THEN
 BEGIN
  Write('90% ');
```

```
 END;
END;

BEGIN
FLAG := False;
ClrScr;
Filenames(FLAG);
Open_files;
Randomize;
Iterations(N);
ClrScr;
Read_data;
Calc_first_T(T);
Report1(T);
Count:=0;
T_Total:=0;
REPEAT
T_total :=T_total+T;
Count:=Count+1;
Calc_sample_T(T);
Progress(Count,N);
IF (FLAG=TRUE) THEN
BEGIN
  WriteT(T);
END;
UNTIL (Count=N);
T_average:=T_total/Count;
Report2(Count,T_average);
Close_Files;
Writeln(' END');
Sound(2000);
Delay(100);
Nosound;
END.
```

APPENDIX F

FOLLOW UP STUDY: BOOTSTRAP ALGORITHM
ESTIMATION OF *t* FOR 'HAPPY' GROUP (*n*=8) USING DIFFERENCE SCORES
PASCAL SOURCE CODE

```
Program Boot_T2;
{does N iterations to calculate T for one sample based on difference
scores pre/post. Happy group}

USES CRT;

TYPE
DIFFERENCES = Array[1..8] OF REAL; {Input file of difference values}
D_SQUARED = Array[1..8] OF REAL; {array of DIFFERENCES squared}
SAMPLE = Array[1..8] OF REAL; {generated sample}

VAR
 Infile : TEXT;
 Outfile : TEXT;
 DIFF : DIFFERENCES;
 D2 : D_SQUARED;
 S1 : SAMPLE;
 D_loop: INTEGER;
 Dsq, Diff_mean,Sumd2,T,Sums_squares,T_total,Count,T_average,N : REAL;
 Input,Output : String[28];
 Name : String[10];
 FLAG : Boolean;

CONST
 Diff_no = 8;

PROCEDURE Filenames(VAR FLAG: Boolean);
VAR Y : String[1];
BEGIN
 ClrScr;
 Write('INPUT FILE NAME - MAX 25 CHARACTERS >> ');
 Readln(Input);
 Write('OUTPUT FILE NAME - MAX 25 CHARACTERS >> ');
 Readln(Output);
 Write('INPUT VARIABLE NAME >> ');
 Readln(Name);
 Write('DO YOU WISH TO OUTPUT ACTUAL STATISTICS? Y/N >>');
 Readln(Y);
 IF (Y='Y') OR (Y='y') THEN
 BEGIN
   FLAG:=True;
 END;
END;

PROCEDURE Open_Files;
BEGIN
 Assign(Infile,Input);
 Reset(Infile);
 Assign(Outfile,Output);
 Rewrite(Outfile);
END;

PROCEDURE Close_files;
BEGIN
 Close(Infile);
 Close(Outfile);
END;
```

```
Procedure Iterations(VAR N: REAL);
BEGIN
 Write('INPUT ITERATIONS>> ');
 Readln(N);
END;

Procedure Read_data;
BEGIN
 FOR D_loop := 1 TO Diff_no DO
 BEGIN
   Readln(Infile,DIFF[D_loop]);
 END;
END;

{This procedure calculates Dsquared}
Procedure Calc_dsquared(VAR Dsq : REAL);
BEGIN
 Dsq:=0;
 FOR D_Loop := 1 TO DIFF_NO DO
 BEGIN
   D2[D_loop]:=(Diff[D_loop]*Diff[D_loop]);
   Dsq:=Dsq + D2[D_Loop];
 END;
END;

{This procedure calculates the mean of the differences - i.e. just the mean}
{of the input values which are difference values}

Procedure Calc_diff_mean( VAR Diff_mean,Total : REAL);
BEGIN
 Total:=0;
 Diff_mean :=0;
 FOR D_Loop := 1 TO Diff_no DO
 BEGIN
   Total:=Total + DIFF[D_loop];
 END;
 Diff_mean := Total/Diff_no;
END;

{This procedure calculates the (sum of d)squared /N}
Procedure Calc_sumd2(VAR sumd2 : REAL; Total : Real);
BEGIN
 Sumd2 := (Total*Total);
END;

{N.B. This procedure calculates the first T value only!!!!}
Procedure Calc_first_T(VAR T: REAL);
VAR Total : REAL;
BEGIN
 Calc_dsquared(Dsq);
 Calc_diff_mean(Diff_mean, Total);
 Calc_sumd2(sumd2, Total);
 Sums_squares := Dsq-(Sumd2/Diff_no);
 T:= Diff_mean/(Sqrt(Sums_squares/(Diff_no*(Diff_no-1))));
END;

Procedure Random_sample;
```

```
VAR R: INTEGER;
BEGIN
 FOR D_Loop := 1 TO Diff_no DO
 BEGIN
  R:=(Trunc(Random*Diff_no)+1);
  S1[D_loop]:=Diff[R];
 END;
END;

{++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}
{ ALL PROCEDURES NOW USE ARRAY S1 WHICH IS A RANDOM SAMPLE FROM THE ORIGINAL
}
{++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}

{This procedure calculates Dsquared}
Procedure Calc_dsquaredS1(VAR Dsq : REAL);
BEGIN
 Dsq:=0;
 FOR D_Loop := 1 TO DIFF_NO DO
 BEGIN
  D2[D_loop]:=(S1[D_loop]*S1[D_loop]);
  Dsq:=Dsq + D2[D_Loop];
 END;
END;

{This procedure calculates the mean of the differences - i.e. just the mean}
{of the input values which are difference values}

Procedure Calc_diff_meanS1( VAR Diff_mean,Total : REAL);
BEGIN
 Total:=0;
 Diff_mean :=0;
 FOR D_Loop := 1 TO Diff_no DO
 BEGIN
  Total:=Total + S1[D_loop];
 END;
 Diff_mean := Total/Diff_no;
END;

{This procedure calculates the (sum of d)squared /N}
Procedure Calc_sumd2S1(VAR sumd2 : REAL; Total : Real);
BEGIN
 Sumd2 := (Total*Total);
END;

{N.B. This procedure calculates the T value from the random sample}
Procedure Calc_Sample_T(VAR T: REAL);
VAR Total : REAL;
BEGIN
 Random_sample;
 Calc_dsquaredS1(Dsq);
 Calc_diff_meanS1(Diff_mean, Total);
 Calc_sumd2S1(sumd2, Total);
 Sums_squares := Dsq-(Sumd2/Diff_no);
 T:= Diff_mean/(Sqrt(Sums_squares/(Diff_no*(Diff_no-1))));
END;
```

```
{++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}
{++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}

Procedure WriteT(T: REAL);
BEGIN
 Writeln(Outfile,T:8:5);
END;

Procedure Report1(T: REAL);
BEGIN
 Write(Outfile,'T STATISTIC FOR THE PRE/POST DIFFERENCE FOR THE ');
 Write(Outfile,'VARIABLE ~',Name,'~: ',T:8:5);
 Writeln(Outfile);
END;

Procedure Report2(Count,T_average: REAL);
BEGIN
 Write(Outfile,'Bootstrap estimate of T for ',Count:15:0,' iterations: ');
 Writeln(Outfile,T_average:12:7);
END;

Procedure Progress(Count,N : REAL);
BEGIN
 IF (Count =(N/10)) THEN
 BEGIN
  Write('10% ');
 END;
 IF (Count =(2*(N/10))) THEN
 BEGIN
  Write('20% ');
 END;
 IF (Count =(3*(N/10))) THEN
 BEGIN
  Write('30% ');
 END;
 IF (Count =(4*(N/10))) THEN
 BEGIN
  Write('40% ');
 END;
 IF (Count =(5*(N/10))) THEN
 BEGIN
  Write('50% ');
 END;
 IF (Count =(6*(N/10))) THEN
 BEGIN
  Write('60% ');
 END;
 IF (Count =(7*(N/10))) THEN
 BEGIN
  Write('70% ');
 END;
 IF (Count =(8*(N/10))) THEN
 BEGIN
  Write('80% ');
 END;
 IF (Count =(9*(N/10))) THEN
 BEGIN
```

```
  Write('90% ');
 END;
END;

BEGIN
FLAG := False;
ClrScr;
Filenames(FLAG);
Open_files;
Randomize;
Iterations(N);
ClrScr;
Read_data;
Calc_first_T(T);
Report1(T);
Count:=0;
T_Total:=0;
REPEAT
T_total :=T_total+T;
Count:=Count+1;
Calc_sample_T(T);
Progress(Count,N);
IF (FLAG=TRUE) THEN
BEGIN
 WriteT(T);
END;
UNTIL (Count=N);
T_average:=T_total/Count;
Report2(Count,T_average);
Close_Files;
Writeln(' END');
Sound(2000);
Delay(100);
Nosound;
END.
```

APPENDIX G

FOLLOW UP STUDY: BOOTSTRAP ALGORITHM

ESTIMATION OF *MEAN* AND *SD* FOR 'SAD' GROUP (n=11)

PASCAL SOURCE CODE

```
Program Mean_std;
{does N iterations to calculate mean and std of a given sample}

USES CRT;

TYPE
DIFFERENCES = Array[1..11] OF REAL; {Input file of difference values}
D_SQUARED = Array[1..11] OF REAL; {array of DIFFERENCES squared}
SAMPLE = Array[1..11] OF REAL; {generated sample}

VAR
 Infile : TEXT;
 Outfile : TEXT;
 DIFF : DIFFERENCES;
 D2 : D_SQUARED;
 S1 : SAMPLE;
 D_loop: INTEGER;
 Dsq, Diff_mean,X,Variance,Std, X_Total,Std_Total,Count,X_average : REAL;
 Std_average,N : REAL;
 Input,Output : String[30];
 Name : String[10];
 FLAG : Boolean;

CONST
 Diff_no = 11;

PROCEDURE Filenames(VAR FLAG: Boolean);
VAR Y : String[1];
BEGIN
 ClrScr;
 Write('INPUT FILE NAME - MAX 25 CHARACTERS >> ');
 Readln(Input);
 Write('OUTPUT FILE NAME - MAX 25 CHARACTERS >> ');
 Readln(Output);
 Write('INPUT VARIABLE NAME >> ');
 Readln(Name);
 Write('DO YOU WISH TO OUTPUT ACTUAL STATISTICS? Y/N >>');
 Readln(Y);
 IF (Y='Y') OR (Y='y') THEN
 BEGIN
  FLAG:=True;
 END;
END;

PROCEDURE Open_Files;
BEGIN
 Assign(Infile,Input);
 Reset(Infile);
 Assign(Outfile,Output);
 Rewrite(Outfile);
END;

PROCEDURE Close_files;
BEGIN
 Close(Infile);
 Close(Outfile);
END;
```

```
Procedure Iterations(VAR N: REAL);
BEGIN
 Write('INPUT ITERATIONS>> ');
 Readln(N);
END;

Procedure Read_data;
BEGIN
 FOR D_loop := 1 TO Diff_no DO
 BEGIN
  Readln(Infile,DIFF[D_loop]);
 END;
END;

{This procedure calculates the mean of the original data set}
Procedure Calc_X(VAR X : REAL; Total : REAL);
BEGIN
 X:=0;
 Total:=0;
 FOR D_Loop := 1 TO DIFF_NO DO
 BEGIN
  Total:=Total+Diff[D_loop];
 END;
 X:=Total/Diff_no;
END;

{This procedure calculates the sum of the squared values (SX2)}
{of the input values which are difference values}

Procedure  Calc_SumXsquared(VAR SX2 : REAL);
BEGIN
 SX2:=0;
 FOR D_Loop := 1 TO Diff_no DO
 BEGIN
  D2[D_Loop]:=(Diff[D_loop]*Diff[D_loop]);
  SX2:=SX2+D2[D_loop];
 END;
END;

{This procedure calculates the (sum of X)squared/N}
Procedure Sumx_squared(VAR SUMX2 : REAL; Total : REAL);
VAR Total2 : REAL;
BEGIN
 SUMX2 := 0;
 Total:=0;
 FOR D_Loop := 1 TO Diff_No DO
 BEGIN
  Total:=Total+Diff[D_Loop];
 END;
 Total2:=Total*Total;
 SUMX2:=Total2/Diff_No;
END;

{N.B. This procedure calculates the first mean (X) and STD value only!!!!}
Procedure Calc_first(VAR Std, X : REAL);
VAR SX2,SUMX2,Total : REAL;
BEGIN
```

```
 Calc_X(X,Total);
 Calc_SumXsquared(SX2);
 Sumx_squared(SUMX2,Total);
 Variance:=(SX2-SUMX2)/(Diff_no-1);
 Std:=Sqrt(Variance);
END;

Procedure Random_sample;
VAR R: INTEGER;
BEGIN
 FOR D_Loop := 1 TO Diff_no DO
 BEGIN
  R:=(Trunc(Random*Diff_no)+1);
  S1[D_loop]:=Diff[R];
 END;
END;

{+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}
{ ALL PROCEDURES NOW USE ARRAY S1 WHICH IS A RANDOM SAMPLE FROM THE ORIGINAL }
{+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}
{This procedure calculates the mean of the original data set}
Procedure Calc_Xs(VAR X : REAL; Total : REAL);
BEGIN
 X:=0;
 Total:=0;
 FOR D_Loop := 1 TO DIFF_NO DO
 BEGIN
  Total:=Total+S1[D_loop];
 END;
 X:=Total/Diff_no;
END;

{This procedure calculates the sum of the squared values (SX2)}
{of the input values which are difference values}

Procedure  Calc_SumXsquareds(VAR SX2 : REAL);
BEGIN
 SX2:=0;
 FOR D_Loop := 1 TO Diff_no DO
 BEGIN
  D2[D_Loop]:=(S1[D_loop]*S1[D_loop]);
  SX2:=SX2+D2[D_loop];
 END;
END;

{This procedure calculates the (sum of X)squared/N}
Procedure Sumx_squareds(VAR SUMX2 : REAL; Total : REAL);
VAR Total2 : REAL;
BEGIN
 SUMX2 := 0;
 Total:=0;
 FOR D_Loop := 1 TO Diff_No DO
 BEGIN
  Total:=Total+S1[D_Loop];
 END;
 Total2:=Total*Total;
 SUMX2:=Total2/Diff_No;
```

```
END;
{N.B. This procedure calculates the mean (X)for the samples}
Procedure Calc_sample(VAR Std, X : REAL);
VAR SX2,SUMX2,Total : REAL;
BEGIN
 Random_Sample;
 Calc_Xs(X,Total);
 Calc_SumXsquareds(SX2);
 Sumx_squareds(SUMX2,Total);
 Variance:=(SX2-SUMX2)/(Diff_no-1);
 Std:=Sqrt(Variance);
END;


{++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}
{++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++}

Procedure Report_sample(Std,X: REAL);
BEGIN
 Writeln(Outfile,X:8:5,'     ',Std:8:5);
END;

Procedure Report1(Std,X: REAL);
BEGIN
 Write(Outfile,'Mean for variable ');
 Write(Outfile,'VARIABLE ~',Name,'~: ',X:8:5,' Std deviation: ',Std:8:5);
 Writeln(Outfile);
END;

Procedure Report_final(Count,X_average,Std_average: REAL);
BEGIN
 Writeln(Outfile,'Bootstrap estimate for ',Count:15:0,' iterations: ');
 Write(Outfile,' Mean ',X_average:12:7,'  ');
 Write(Outfile,' Standard Deviation ',Std_average:12:7);
END;

Procedure Progress(Count,N : REAL);
BEGIN
 IF (Count =(N/10)) THEN
 BEGIN
  Write('10% ');
 END;
 IF (Count =(2*(N/10))) THEN
 BEGIN
  Write('20% ');
 END;
 IF (Count =(3*(N/10))) THEN
 BEGIN
  Write('30% ');
 END;
 IF (Count =(4*(N/10))) THEN
 BEGIN
  Write('40% ');
 END;
 IF (Count =(5*(N/10))) THEN
 BEGIN
  Write('50% ');
```

```
  END;
  IF (Count =(6*(N/10))) THEN
  BEGIN
   Write('60% ');
  END;
  IF (Count =(7*(N/10))) THEN
  BEGIN
   Write('70% ');
  END;
  IF (Count =(8*(N/10))) THEN
  BEGIN
   Write('80% ');
  END;
  IF (Count =(9*(N/10))) THEN
  BEGIN
   Write('90% ');
  END;
 END;

 BEGIN
  FLAG := False;
  ClrScr;
  Filenames(FLAG);
  Open_files;
  Randomize;
  Iterations(N);
  ClrScr;
  Read_data;
  Calc_first(Std,X);
  Report1(Std,X);
  Count:=0;
  X_Total:=0;
  Std_Total:=0;
   REPEAT
    Count:=Count+1;
    Calc_sample(Std,X);
    X_total :=X_total+X;
    Std_total:=Std_total+Std;
    Progress(Count,N);
    IF (FLAG=TRUE) THEN
    BEGIN
     Report_sample(Std,X);
    END;
   UNTIL (Count=N);
 X_average:=X_total/Count;
 Std_average:=Std_total/Count;
 Report_final(Count,X_average,Std_average);
 Close_Files;
 Writeln(' END');
 Sound(2000);
 Delay(100);
 Nosound;
 END.
```

APPENDIX H

MAIN STUDY:
MULTIVARIATE ANALYSIS OF VARIANCE (18 ITEMS)
SPSS RESULT FILE

```
@c:\new\manova.txt
DATA LIST /PRAC 1-3 (A) SEAT 6-7 GENDER 10 LANG 13 COND 16 HAPPY 19-22
SAD 25-28 NEUTRAL 31-34 HNEUTRAL 36-39 SNEUTRAL 42-45 ERRORS 47-48
WORD1 TO WORD19 50-68 ERRH 70-73 ERRS 75-78.
SET /MORE OFF.
SET /LENGTH=54.
@c:\new\data18n.txt
BEGIN DATA
END DATA.
    107 cases are written to the uncompressed active file.

This procedure was completed at 15:33:41
VALUE LABELS GENDER 1 'MEN' 2 'WOMEN'
/LANG 1 'ZULU' 2 'XHOSA' 3 'OTHER AFRICAN LANG' 4 'ENGLISH' 5
'AFRIKAANS'
6 'OTHER'
/COND 1 'SAD' 2 'HAPPY'
/WORD1 TO WORD19 1 'HAPPY' 2 'SAD' 3 'NEUTRAL' 4 'ERROR'.
COMPUTE LANGX=LANG.
RECODE LANGX (2=1) (3=1) (5=1) (6=1) (4=2).
VALUE LABELS LANGX 1 'NON ENGLISH' 2 'ENGLISH'.
MANOVA Errs Errh Happy Sad Sneutral Hneutral BY COND(1,2)
The raw data or transformation pass is proceeding
    107 cases are written to the uncompressed active file.
GENDER(1,2) LANGX(1,2)
/CONTRAST (Cond) deviation.

 - - - - - - - - - - -

NOTE    12167
The last subcommand is not a design specification--A full factorial model
is generated for this problem.


       107 cases accepted.
         0 cases rejected because of out-of-range factor values.
         0 cases rejected because of missing data.
         8 non-empty cells.

         1 design will be processed.

 - - - - - - - - - - -
-----------------------------------------------------------------------------
Page   2                        SPSS/PC+                          12/18/96

* * ANALYSIS  OF  VARIANCE -- DESIGN   1 * *

 EFFECT .. COND BY GENDER BY LANGX
 Multivariate Tests of Significance (S = 1, M = 2 , N = 46 )

 Test Name        Value  Approx. F Hypoth. DF   Error DF  Sig. of F

 Pillais         .06270    1.04802       6.00      94.00       .400
 Hotellings      .06689    1.04802       6.00      94.00       .400
 Wilks           .93730    1.04802       6.00      94.00       .400
 Roys            .06270

 - - - - - - - - - - -
```

Univariate F-tests with (1,99) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
ERRS	.00670	.95104	.00670	.00961	.69715	.406
ERRH	.00498	.77000	.00498	.00778	.64024	.426
HAPPY	.02576	1.57889	.02576	.01595	1.61542	.207
SAD	.00840	2.64866	.00840	.02675	.31382	.577
SNEUTRAL	.00009	2.33406	.00009	.02358	.00398	.950
HNEUTRAL	.00848	1.19328	.00848	.01205	.70316	.404

\- - - - - - - - - - -

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

EFFECT .. GENDER BY LANGX
Multivariate Tests of Significance (S = 1, M = 2 , N = 46)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.04521	.74181	6.00	94.00	.617
Hotellings	.04735	.74181	6.00	94.00	.617
Wilks	.95479	.74181	6.00	94.00	.617
Roys	.04521				

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Univariate F-tests with (1,99) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
ERRS	.01444	.95104	.01444	.00961	1.50268	.223
ERRH	.00458	.77000	.00458	.00778	.58834	.445
HAPPY	.00492	1.57889	.00492	.01595	.30837	.580
SAD	.00617	2.64866	.00617	.02675	.23053	.632
SNEUTRAL	.00182	2.33406	.00182	.02358	.07721	.782
HNEUTRAL	.00000	1.19328	.00000	.01205	.00019	.989

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

EFFECT .. COND BY LANGX
Multivariate Tests of Significance (S = 1, M = 2 , N = 46)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.18895	3.64979	6.00	94.00	.003
Hotellings	.23297	3.64979	6.00	94.00	.003
Wilks	.81105	3.64979	6.00	94.00	.003
Roys	.18895				

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Univariate F-tests with (1,99) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
ERRS	.13948	.95104	.13948	.00961	14.51982	.000

ERRH	.00977	.77000	.00977	.00778	1.25674	.265
HAPPY	.00355	1.57889	.00355	.01595	.22273	.638
SAD	.01202	2.64866	.01202	.02675	.44909	.504
SNEUTRAL	.06759	2.33406	.06759	.02358	2.86686	.094
HNEUTRAL	.02666	1.19328	.02666	.01205	2.21147	.140

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

EFFECT .. COND BY GENDER
Multivariate Tests of Significance (S = 1, M = 2 , N = 46)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.11269	1.98966	6.00	94.00	.075
Hotellings	.12700	1.98966	6.00	94.00	.075
Wilks	.88731	1.98966	6.00	94.00	.075
Roys	.11269				

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Univariate F-tests with (1,99) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
ERRS	.04598	.95104	.04598	.00961	4.78686	.031
ERRH	.00556	.77000	.00556	.00778	.71477	.400
HAPPY	.01340	1.57889	.01340	.01595	.84027	.362
SAD	.00154	2.64866	.00154	.02675	.05762	.811
SNEUTRAL	.06442	2.33406	.06442	.02358	2.73244	.101
HNEUTRAL	.03661	1.19328	.03661	.01205	3.03708	.084

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

EFFECT .. LANGX
Multivariate Tests of Significance (S = 1, M = 2 , N = 46)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.55480	19.52345	6.00	94.00	.000
Hotellings	1.24618	19.52345	6.00	94.00	.000
Wilks	.44520	19.52345	6.00	94.00	.000
Roys	.55480				

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Univariate F-tests with (1,99) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
ERRS	.75860	.95104	.75860	.00961	78.96715	.000
ERRH	.51709	.77000	.51709	.00778	66.48317	.000
HAPPY	.43312	1.57889	.43312	.01595	27.15772	.000
SAD	.04028	2.64866	.04028	.02675	1.50543	.223
SNEUTRAL	.43285	2.33406	.43285	.02358	18.35945	.000
HNEUTRAL	.00529	1.19328	.00529	.01205	.43856	.509

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

EFFECT .. GENDER
Multivariate Tests of Significance (S = 1, M = 2 , N = 46)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.14776	2.71631	6.00	94.00	.018
Hotellings	.17338	2.71631	6.00	94.00	.018
Wilks	.85224	2.71631	6.00	94.00	.018
Roys	.14776				

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Univariate F-tests with (1,99) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
ERRS	.00639	.95104	.00639	.00961	.66472	.417
ERRH	.00592	.77000	.00592	.00778	.76100	.385
HAPPY	.00954	1.57889	.00954	.01595	.59835	.441
SAD	.16068	2.64866	.16068	.02675	6.00567	.016
SNEUTRAL	.10232	2.33406	.10232	.02358	4.34013	.040
HNEUTRAL	.02846	1.19328	.02846	.01205	2.36085	.128

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

EFFECT .. COND
Multivariate Tests of Significance (S = 1, M = 2 , N = 46)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.19291	3.74472	6.00	94.00	.002
Hotellings	.23902	3.74472	6.00	94.00	.002
Wilks	.80709	3.74472	6.00	94.00	.002
Roys	.19291				

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Univariate F-tests with (1,99) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
ERRS	.17386	.95104	.17386	.00961	18.09767	.000
ERRH	.00214	.77000	.00214	.00778	.27515	.601
HAPPY	.03233	1.57889	.03233	.01595	2.02735	.158
SAD	.00415	2.64866	.00415	.02675	.15511	.695
SNEUTRAL	.12156	2.33406	.12156	.02358	5.15613	.025
HNEUTRAL	.01740	1.19328	.01740	.01205	1.44378	.232

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 2 , N = 46)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	1.00000	3147054.77	6.00	94.00	.000
Hotellings	200875.837	3147054.77	6.00	94.00	.000
Wilks	.00000	3147054.77	6.00	94.00	.000
Roys	1.00000				

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Univariate F-tests with (1,99) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
ERRS	1.18222	.95104	1.18222	.00961	123.06480	.000
ERRH	.84689	.77000	.84689	.00778	108.88694	.000
HAPPY	19.92198	1.57889	19.92198	.01595	1249.15363	.000
SAD	8.05653	2.64866	8.05653	.02675	301.13218	.000
SNEUTRAL	13.20078	2.33406	13.20078	.02358	559.91565	.000
HNEUTRAL	4.60903	1.19328	4.60903	.01205	382.38703	.000

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12528 BYTES OF WORKSPACE NEEDED FOR MANOVA EXECUTION.

APPENDIX I

MAIN STUDY:
RESPONSES TO RECALL TEST

Happy: condition: Subject recalled phrase: do not know
Sad condition: Subject recalled phrase: don't know
Sad condition: Subject recalled phrase: Easier
Happy condition: Subject recalled phrase: BE AT SCHOOL
Happy condition: Subject recalled phrase: dont know
Sad condition: Subject recalled phrase: don't know
Sad condition: Subject recalled phrase: run around
Happy condition: Subject recalled phrase: DONT KNOW
Happy condition: Subject recalled phrase: dont know
Sad condition: Subject recalled phrase: don't know
Happy condition: Subject recalled phrase:
Sad condition: Subject recalled phrase: dont know
Sad condition: Subject recalled phrase: confused
Sad condition: Subject recalled phrase: don't know
Happy condition: Subject recalled phrase: DONT KNOW
Sad condition: Subject recalled phrase: don't know
Happy condition: Subject recalled phrase: dont known
Happy condition: Subject recalled phrase: don not know
Sad condition: Subject recalled phrase: Don't Know
Happy condition: Subject recalled phrase: don't know
Sad condition: Subject recalled phrase: don"t know
Sad condition: Subject recalled phrase: DONT KNOW
Happy condition: Subject recalled phrase: donotknow
Sad condition: Subject recalled phrase: don,tknow
Happy condition: Subject recalled phrase: dont know
Sad condition: Subject recalled phrase: summsum
Happy condition: Subject recalled phrase: horse
Happy condition: Subject recalled phrase:
Sad condition: Subject recalled phrase: flashed
Sad condition: Subject recalled phrase: dont know
Happy condition: Subject recalled phrase: dont know
Happy condition: Subject recalled phrase: happy
Sad condition: Subject recalled phrase: psychology
Happy condition: Subject recalled phrase: under
Happy condition: Subject recalled phrase: HELP
Sad condition: Subject recalled phrase: abn
Happy condition: Subject recalled phrase: no idea
Sad condition: Subject recalled phrase: HELP
Happy condition: Subject recalled phrase: HELP
Happy condition: Subject recalled phrase: please help
Sad condition: Subject recalled phrase: SCREEN
Sad condition: Subject recalled phrase: away
Happy condition: Subject recalled phrase: HAPPY
Sad condition: Subject recalled phrase: HOSTEL
Sad condition: Subject recalled phrase: running
Happy condition: Subject recalled phrase: I don't know
Happy condition: Subject recalled phrase: look hard

Sad condition: Subject recalled phrase: ok
Sad condition: Subject recalled phrase: e pi
Happy condition: Subject recalled phrase: Thabani Mbhele
Sad condition: Subject recalled phrase:
Happy condition: Subject recalled phrase:
Happy condition: Subject recalled phrase: MATHS SYMBOLS
Happy condition: Subject recalled phrase: PATTERNS
Happy condition: Subject recalled phrase: be
Sad condition: Subject recalled phrase: happy
Sad condition: Subject recalled phrase: psychology
Sad condition: Subject recalled phrase: dont know
Sad condition: Subject recalled phrase: music
Sad condition: Subject recalled phrase: house
Happy condition: Subject recalled phrase: b
Happy condition: Subject recalled phrase: dont know
Happy condition: Subject recalled phrase: i do not know
Happy condition: Subject recalled phrase: smilling face
Sad condition: Subject recalled phrase: please be back
Sad condition: Subject recalled phrase: I DONT KNOW
Happy condition: Subject recalled phrase:
Sad condition: Subject recalled phrase: o
Sad condition: Subject recalled phrase: dont know
Happy condition: Subject recalled phrase: I REALLY DONT K
Happy condition: Subject recalled phrase: reboo
Sad condition: Subject recalled phrase: desiree
Happy condition: Subject recalled phrase:
Sad condition: Subject recalled phrase: dont know
Happy condition: Subject recalled phrase: dont know
Happy condition: Subject recalled phrase: berttbr
Happy condition: Subject recalled phrase: DONT KNOW
Sad condition: Subject recalled phrase: #$&$%%&
Sad condition: Subject recalled phrase: k.x--op====x
Sad condition: Subject recalled phrase: DONT KNOW
Happy condition: Subject recalled phrase: GREECKLETTERS
Sad condition: Subject recalled phrase:
Sad condition: Subject recalled phrase: do not know
Sad condition: Subject recalled phrase: buildings of an
Sad condition: Subject recalled phrase: dont know
Happy condition: Subject recalled phrase: dont know
Sad condition: Subject recalled phrase: do not know
Sad condition: Subject recalled phrase: psychology
Happy condition: Subject recalled phrase: HOW ARE YOU
Happy condition: Subject recalled phrase: i don't know
Sad condition: Subject recalled phrase: seeing is belie
Sad condition: Subject recalled phrase:
Sad condition: Subject recalled phrase: think
Happy condition: Subject recalled phrase: nothing

Happy condition:	Subject recalled phrase: what is your
Happy condition:	Subject recalled phrase: haroon
Happy condition:	Subject recalled phrase: happy
Happy condition:	Subject recalled phrase: don'tknow
Sad condition:	Subject recalled phrase: white flash
Happy condition:	Subject recalled phrase: I DIDN'T SEE AN
Sad condition:	Subject recalled phrase: nothing was see
Happy condition:	Subject recalled phrase: TRY HARD
Happy condition:	Subject recalled phrase: practical
Sad condition:	Subject recalled phrase: the dog
Happy condition:	Subject recalled phrase:
Sad condition:	Subject recalled phrase: the hands of
Sad condition:	Subject recalled phrase: NO

APPENDIX J

WORD RATING QUESTIONNAIRE

HOME LANGUAGE: (X)

1. ZULU ☐ *2. XHOSA* ☐ *3. OTHER AFRICAN LANGUAGE* ☐ *4. ENGLISH* ☐ *5. AFRIKAANS* ☐ *6. OTHER* ☐

INSTRUCTIONS: Please rate the following list of words by making a ring on the number on each scale, indicating how you think each word is related to the emotion in question.

word	Related to **HAPPINESS** ① 2 3 ④ 5 6 ⑦ not at all moderately highly	Related to **SADNESS** ① 2 3 ④ 5 6 ⑦ not at all moderately highly	HOW OFTEN **USED** BY YOU ① 2 3 ④ 5 6 ⑦ never sometimes often
medal:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
meddle:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
hymn:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
him:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
die:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
dye:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
sweet:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
suite:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
won:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
one:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
mourning:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
morning:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
heal:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
heel:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
bridal:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
bridle:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
presents:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
presence:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
banned:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
band:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
bored:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
board:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
dear:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
deer:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
missed:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
mist:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
fined:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
find:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
peace:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
piece:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
rose:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
rows:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
pride:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
pried:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
pain:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
pane:	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7

THANK YOU FOR YOUR TIME